THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 58 Thursday, March 31, 1938 No. 1128

PUBLISHED WEEKLY

Subscription Terms: 17s. 6d. per annum.
Foreign and Colonial: 20s. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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Customs of the Trade

From time to time we receive requests from readers to interpret "customs of the trade," and in general we deem them to be entirely unsatisfactory. Far better is it to print boldly on the back of all correspondence relating to business a series of clauses in plain English which everybody can understand. We deprecate the use of pale and illegible type which certain firms have adopted. We have before us the terms set out by an Australian reader. There are but nine clauses, which deal successively with: (1) General; (2) quotations; (3) care of patterns; (4) delivery; (5) delay in delivery; (6) guarantee; (7) verbal instructions; (8) patterns and (9) alterations. The first clause merely draws attention to the application of those which follow and their general application to all orders. The second states that quotations are net and are subject to confirmation before acceptance. The third one, that of care of patterns, postulates that the foundry undertakes no responsibility in respect of customers' patterns unless special arrangements are made. Two clauses are devoted to delivery, the first one defining the delivery period as starting when everything necessary—order, patterns, drawings and other information—required to enable work to proceed has been received. The second is a disclaimer of liability consequent upon strikes, lock-outs, machinery breakdown or other causes beyond the control of the foundry.

The guarantee given—a vitally important clause—is limited to the replacement of a defective casting, if the defect is reported within a month of the date of delivery. Moreover, at the discretion of the sellers the defective casting has to be returned to the foundry at the customer's expense. Under clause 7 verbal understandings are implicitly excluded from any recognition, whilst clause 8 defines the policy towards patterns. No responsibility is taken for dimensional correctness of patterns to drawings unless they have been made by the foundry. Here there is a tacit assumption, reasonably well founded, that an inaccurate pattern yields a dimensionally incorrect casting. This clause insists that patterns should carry distinctive colours for the identification of core prints, machined surfaces and rough casting, and should be numbered. Apparently the position is insufficiently strong to say "must" instead of "should." The final clause insists that customers must pay the cost of any work discarded due to alterations of patterns, coreboxes, etc., or stopping of work.

It is not put forward that the above conditions of sale are perfect, but in general they give to the foundry a much better protection than relying on customs of the trade. The latter may vary from district to district, and legal evidence in their support is not easy to produce. Moreover, probably legal warrantee applicable to every commercial transaction is of more importance than trade customs. If our memory serves us correctly, in the famous singing propeller case, the learned judge made analogies with taxi cabs and saddles. In general we deem custom of the trade a pretty poor legal peg upon which to hang a commercial hat.

Welding Cast Iron and Steel

Gratifying progress is being made in plans for research on welding both in this country and in U.S.A. The foundry industry should see to it that cast iron and steel are fully cared for in this matter, and its own attitude to welding should be thought out. The general view of welding taken by the industry as a whole is coloured by its apprehension of welding as a rival in the fabrication of structures. But such use is all the more reason why the maker of castings should get all the benefit he can from welding. We have never quite been able to understand the reason for the attitude of steel founders to welding, which at best covers a desire never to mention the subject if it can be avoided. We see no reason why proper investigation should not be made, and it is not at all improbable that this could establish the entire respectability of welding and convince buyers that it is not even objectionable but possibly quite desirable as a means of repair. Similar considerations apply to the welding of cast iron, now fairly well established on a commercial basis, but presenting a number of difficulties which want solving if it is to be used generally and with confidence. Welding is a metallurgical operation. Cast iron contains much more combined carbon and graphite than the steels usually regarded as weldable. The simple process of heating, melting and solidifying involved in welding is the foundry art in miniature, providing in the space of a few seconds the opportunity for all the complex processes and difficulties that have baffled foundry metallurgists for generations. How many foundries, we wonder, still have occasion to practise that particular form of autogenous welding usually called "burning-on"? How far can the metal be modified to make it more readily weldable? The austenitic irons, on account of their resistance to oxidation, are very easily welded, and are actually used in rod form. All these and other possibilities should be taken into account.

C

The German Foundry Industry

Recent developments in the German foundry industry, showing number of foundries, employment, production in tons and value of products in Rmk., are given in Table I for the period 1932-36. The 22.5 per cent. increase (600,000 tons) in 1936 over 1935 is the greatest advance shown by any section of the German iron and steel industry. It may be noted that foundries are fairly uniformly distributed over Germany and not localised as the iron and steel works.

TABLE I.—*Statistical Information of the German Foundry Industry.*

Year.	No. of works.	No. of workpeople.	Value of production in million Rmk.
1932 ..	1,240	60,582	285.4
1933 ..	1,242	88,222	245.2
1934 ..	1,867	113,690	581.3
1935 ..	1,867	131,455	785.3
1936 ..	1,319	156,605	879.1

As the bulk of the castings made are engineering castings (1936, 1,242,775 tons) it is apparent that the engineering industry is largely dependent on the foundries. The proportions of products made in iron, malleable and steel foundries have not altered much during the past few years. Engineering castings, pipes and steel castings continue to make headway, while grate and stove castings as well as brake-block castings are still losing ground. The distribution of the output according to products is given in Table II.

TABLE II.—*Distribution of Output of German Foundries.*

	1934. Per cent.	1935. Per cent.	1936. Per cent.
Grey castings—	87.2	87.6	87.5
Engineering castings	34.7	36.5	37.1
Pipes and connections	11.5	12.9	13.4
"Works" castings (ingot moulds, moulding boxes) ..	9.2	10.2	10.6
Radiators, boilers, gilled pipes ..	9.7	7.6	7.6
Stove and grate castings	5.3	4.1	3.5
Roll castings ..	3.3	3.3	3.0
Builders' castings ..	2.9	3.1	3.2
Brake blocks ..	2.8	2.3	2.1
Miscellaneous ..	7.8	7.8	7.0
High-duty castings ..	4.7	3.8	3.6
Steel castings	4.7	5.4	5.6
Malleable castings ..	3.4	3.2	3.3

Engineering castings are the principal products in nearly all areas, while steel castings are made principally in Westphalia. More than 30 per cent. of the foundry output is accounted for by the Rhine province. Roll castings account for more than 80 per cent. of the output in West and North-West Germany.

Consumption of pig-iron in foundries increased from 1,600,000 tons in 1935 to 2,000,000 tons in 1936, *i.e.*, by about 25 per cent. Consumption of scrap, other than return scrap, increased by 300,000 tons to 1,600,000 tons.

Publication Received

Electric Heat, No. 9. Issued by the British Electric Development Association, 2, Savoy Hill, London, W.C.2. Gratis on application.

Previous issues of this series have dealt with major problems such as iron and steel heat-treatment equipment and vitreous enamelling, but this one introduces such questions as soft metal melting, roll warming and laboratory hot-plates. In all, over one hundred applications are dealt with, some of which are, of course, well removed from foundry or even metallurgical works practice.

Notes from the Branches

Falkirk Section.—At the March meeting of the Falkirk Section of the Institute of British Foundrymen Mr. Robert J. Shaw was formally adopted as President in succession to Mr. H. Cowan, who is now in the Midlands. Other appointments were:—Mr. Donaldson, Senior Vice-President; Mr. Cunningham, Junior Vice-President; and Mr. T. Goodwin, Secretary. Messrs. Kidd, Wilson and Smith were elected to vacancies on the committee.

Mr. Shaw then addressed the members on the subject of "Patternmaking in the Light-Castings Industry." A full report of his address appears elsewhere in this issue.

East Anglian Section.—The annual general meeting of the East Anglian Section of the Institute of British Foundrymen was held on March 17, Mr. L. J. Tibbenham being in the chair. The annual report, which was read by the Secretary, stated that membership of the Section had increased from 44 to 52. Activities during the period covered included five ordinary meetings, three works visits, and the annual dinner. Attendance at these visits and meetings had been very good indeed. Meetings were held at Colchester, Norwich, and the rest at Ipswich. At Norwich the meeting was a joint one with the Norwich Engineering Society, and the co-operation and facilities extended by this body were valuable. Mr. H. H. Shepherd (Junior Vice-President) had been awarded the Institute Diploma for his Paper on "Application of Science to the Control of Foundry Sands," and Mr. A. R. Parkes gained second Prize in the Lancashire Branch Coronation Competition for a Paper entitled "Metallurgical Control in a Repetition Foundry Producing Grey Cast Iron."

For the forthcoming Session the following officers were elected: As President, Col. C. Portway; as Senior Vice-President, Mr. H. H. Shepherd; as Junior Vice-President, Mr. G. Hall, and Honorary Secretary, Mr. J. L. Francis. To serve on the committee, Mr. F. Tibbenham and Mr. H. T. Brown.

Following the annual meeting a Short Paper Competition was held.

Improved Open-Hearth Charging

In the course of a Paper on "Developments in the Iron and Steel Industry," referring particularly to the United States, MR. W. H. BURR, writing in "Iron and Steel Engineer," states that during the year 1937, there has been developed a new process or method which will permit of a large part, if not all, of the entire charge of cold metal required for a melting heat, to be deposited in the open-hearth furnace at one time, thereby effecting a more economical method as to power and fuel consumption, speed of operation, as well as maintenance cost of the charging equipment and furnace. Briefly, it consists of a furnace construction having a removable furnace front permitting the use of a novel charging machine which employs a container of ample size to hold the entire charge. The container or pan is adapted to be filled with its cold metal charge at any convenient point. The pan has a flexible rolling bottom substantially equal in area to the furnace hearth area to be charged, the discharge of the cold metal from the pan being such that the layer on the hearth will be approximately the thickness and area of the layer on the pan. The novel features of the furnace construction and the charging machine are the subject matter of pending patents for which numerous claims have been allowed.

IRONFOUNDING WORKERS in Scotland will probably receive payment for holidays this year. It has been stated on behalf of the Employers' Federation that they are in agreement with the principle. The rates to be paid will, it is stated, be the agreed rates for day workers.

Random Shots

Now that spelling bees have once again come into prominence, it is suggested that one might be organised at Branch meetings of the I.B.F. as a departure from the frequent end-of-session short Paper contests. The words chosen should answer to a hardness test of at least 600 Brinell and might include such stumbling blocks as cupolo, Seamen's, Sessi, Bracklesborough, Tilmann, aliminium, Rampadson, Newleck, sillacene, Glyco, Spermalin, Jeerjejefsky, Pivovarsky, and Mackensom!

* * *

The "Iron Age" is publishing a series of vignettes on the characteristics of its personalities, beginning with the Editor-in-Chief. Of him it is said that "If he had 10 minutes to finish an editorial before press closing time, and a half-hour to do half a dozen other jobs before catching a train for a trip to some place, and you walked in on him, you'd never know it." Evidently this is the stuff of which Editors are made! There are very few visitors to 49, Wellington Street who realise which day is leader day or which is press day, for the atmosphere of that office is always—as far as "Marksman" knows—calm and peaceful.

* * *

A school teacher said to one of her pupils, "Why did you not come to see me after school, as I said?"

"You was out," promptly answered the pupil.

"You *was* out?" queried the horrified champion of King's English.

"No, Miss, *you* was out," persisted the child.

* * *

American readers are not expected to see any point in this story, any more than they were expected to understand why, at a large international dinner, the English laughed when the American speaker got up and said: "We have all just returned from a tour of the North of England feeling very fresh."

* * *

Following on the same thought, it will not be so many generations ahead that people will see no rhyme nor reason in many of the proverbs and savings of to-day which seem to be such potted wisdom, so aptly phrased. "To put the cart before the horse" will be a phrase to put in the museum when the world is completely run by machinery. One can hear, too, some Modern Miss of a hundred years hence saying: "Did you really have fires in your houses? And did you really get your irons hot in them?" when some ancient relative tells her that she has got "too many irons in the fire at once." Goodness only knows what lighting medium they will burn at both ends. It certainly won't be the candle. One imagines, though, if things progress in the same spirit as they are doing now, they will thoroughly appreciate the significance of such sayings as "the end justifies the means" and "All's fair in love and war."

* * *

Said the mistress to her new maid in an endeavour to make her orders as simple as possible: "Will you please fetch in the white wine from the dining room?"

A long time elapsed before the maid appeared at the door.

"I'm sorry, ma'am," said she, "I can't find any white wine anywhere. There's only yellow."

"MARKSMAN."

London Transport's Big Order

The London Passenger Transport Board has placed orders for rolling stock to the value of nearly £9,000,000 for use on the Morden-Edgware and Bakerloo lines. The order has been divided between Gloucester and Birmingham firms, and in Gloucester especially it will mean a substantial addition to employment.

Some Points on Non-Ferrous Foundry Practice*

By A. PHILLIPS†

In surveying the field of non-ferrous foundry work there are some points which appeal more strongly than others as showing the need for discussion to assist in the further progress of the industry. The type of work in small non-ferrous foundries is totally different in manufacture from the work in larger foundries, and, again, the foundries which produce aluminium alloy castings and die-castings have different problems from the others.

However, there are certain principles in foundry technique which are common to all, and whilst this Paper may mention certain points with which some foundrymen are fully conversant, these can no doubt be improved by suggestions brought out by co-operative discussion. Naturally, as non-ferrous foundry practice includes so many varying classes of work, of so many shapes and sizes of patterns and different types of alloys, only a brief description of a few can be given.

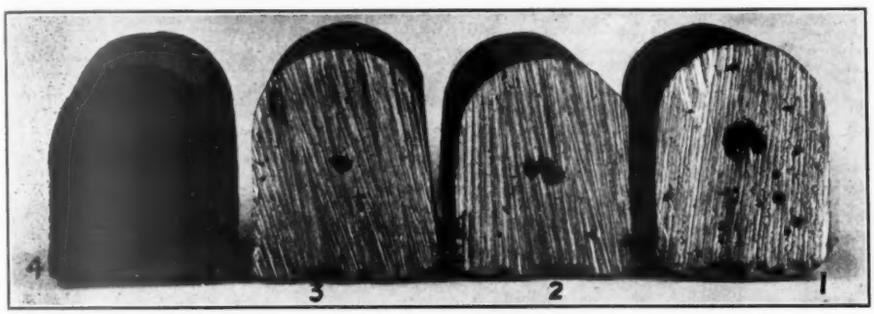

FIG. 1.—CAST COPPER INGOTS, SHOWING GAS POROSITY.

COPPER CASTINGS

For the electrical industry copper castings having a conductivity of 80 per cent. or over are called for, and have been used for a number of years. In the engineering and electrical industry, their casting technique in the non-ferrous foundry has not received the attention of writers that other alloys have done. Copper castings can be, and are, made in brass foundries using standard equipment and methods with which foundrymen are familiar. The important points in the foundry practice are:—(*a*) Use of electrolytic copper ingots; (*b*) correct melting and fluxing; (*c*) suitable and exact amount of de-oxidiser; (*d*) pouring without turbulence and controlled pouring temperature; (*e*) control of freezing to avoid shrinkage defects, and (*f*) attention to contamination of scrap.

Electrolytic Copper Castings

It must be fully realised that if high-conductivity castings are sought, the purest of ingot metal must be used. Copper oxide is not revealed by chemical analysis, so that determination of the suitability of copper by analysis only is ruled out, although the chemical analysis will show if there are any undesirable elements.

Melting Conditions

The metal can be successfully melted in a crucible furnace. To protect the metal during melting it is usually recommended that it be covered with a layer of some flux which is not very gassy. It is not advisable to place charcoal at the bottom of a hot crucible, as there is a strong tendency for charcoal to absorb moisture and gases, which, if not burned, may cause gas porosity in the metal. Charcoal can absorb about 10 per cent. moisture on exposure to the air. The melting process itself is very important, and it must not be carried out in a reducing atmosphere. A neutral atmosphere is to be aimed for, but, failing this, one should have a slightly oxidising atmosphere.

It obviously appears paradoxical to recommend an oxidising atmosphere when initially the copper must be as free from oxygen as possible. In a reducing atmosphere, unburnt fuel gases other than oxygen are liable to be absorbed by the metal, and these cannot be removed by de-oxidisers. Therefore, it yields a casting which has a gas porosity. If, however, there is a slightly oxidising atmosphere, the oxide absorbed can be removed from the liquid metal by deoxidisers. Also, oxide in this form is not as stable in the molten metal as oxides which are present in the initial solid material.

The fact that castings do sometimes contain hollow cavities or gas holes has led to a number of authorities studying the relationship which exists between gases in the metal under widely varying conditions. Without going deeply into the subject it may be considered under three headings:—(1) Metal may absorb gas at a low temperature, and give it out again when the temperature is raised. (2) Gas may result from reactions which occur within the metal whilst it is in process of solidification, or after it has been partly solidified; with this condition it is impossible to cast a sound casting. (3) The gas may be dissolved in metal much as air dissolves in water; ordinary water contains more or less air in solution, and when water is heated or the pressure reduced, bubbles of gas appear. Everyone is familiar with this reaction.

Solubility of Gases

The solubility of gases in non-ferrous metals is, however, a very complicated study, and from the foundryman's point of view gas reaction presents a great difficulty. It is in the recognition and classification of these symptoms that the foundryman needs assistance. He then has a number of methods of handling the situation. Volumes have been written about the cures for various defects as operated from the laboratory, where it is possible to reproduce similar conditions, but it is more difficult for the foundryman, as he operates under conditions peculiar to his shop and plant. When an infallible method of detecting the fault is available, half the foundryman's troubles will be over. The remedies he can use are:—(*a*) Sufficiently long melting to complete certain reactions; (*b*) addition of a suitable reducing chemical agent, and (*c*) addition of some element which will assist the metal to absorb the gases. The first essential to negative gas effects and one that is of great practical importance is proper and correct melting coupled with the most suitable pouring temperature.

High Conductivity

In the melting of copper for copper castings, the addition of elements or material to reduce gas effects is very limited, and the choice is made from those which, whilst removing the gas effects, retain a high conductivity. Among others there are boron and silicon.

Silicon is introduced by the addition of 15 per cent. silicon-copper. Just sufficient must be added to complete the reaction, as any excess will lower the conductivity and make the metal brittle. Silicon when added to copper containing oxide of copper reduces the copper oxide to copper + silicon oxide. The silica insoluble in copper rises and is skimmed off. As different consignments of the high-grade copper will vary, the exact amount of silicon-copper to add to neutralise the effects of dissolved gas and oxides is very difficult to estimate, and probably the best practical method is to make a trial melt. This can be carried out in the following manner. Melt 100 lbs. under a suitable flux, raise to a temperature of 1,200 deg. C., then add 1¾ ozs. of silicon-copper (this being just below the quantity used in usual practice), and stir with a plumbago stirrer. Pour small ingots at 1,160 deg. C., and when cold examine top and the fracture. Repeat by adding or reducing the amount until correct quantity has been determined. No. 1 section of Fig. 1 shows a high-grade electrolytic copper melted without any addition. During solidification the top of such an ingot bleeds and flows over, and the section shows it to be full of gas holes; No. 2 carried an addition of 1½ ozs. of silicon-copper and shows

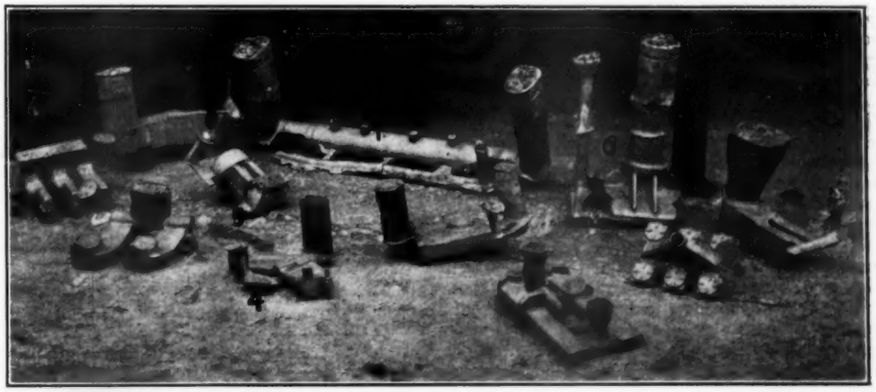

FIG. 2.—COPPER CASTINGS WITH DIFFERENT TYPES OF RUNNERS AND RISERS.

* Paper presented to the Lancashire Branch of the Institute of British Foundrymen.

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fewer gas holes; No. 3 with 1¾ ozs. of silicon-copper showed a rise of the top face with a few gas holes in the section, and the final one, No. 4, with an addition of 2 ozs. of silicon-copper exhibited a flat top and a section free from gas holes.

Moulding

The moulding in general follows quite closely the practice adopted for manganese-bronze, with a slight modification in the gating. As every foundryman will agree, each pattern is a problem in itself, and should be treated as such. In general the runner is very small; in fact, in some instances only a flash thick, as is shown by casting No. 1 in Fig. 2. This illustration shows various copper castings with different positions of runners. Some on the left side of the picture, No. 2 and No. 3, enter directly into the feeding head. In this case the temperature of the metal in the head is hotter than in the casting, thus ensuring that the castings will be fed with hotter metal. Others in the centre, No. 4 and No. 5, for instance, feed direct into the casting; and on the extreme right No. 6 is fed by means of the skim or bridge runner—a type such as is used on all manganese-bronze castings to prevent dross entering the mould. It will be noticed this is a deep casting poured at the bottom; hence the use of a skim or bridge runner.

As the liquid and solidification shrinkage of cast copper is high, the foundryman prevents the formation of voids which are due to a shortage of liquid metal just before or at the moment of solidification, by the use of a proper feeding head, which is supplied with hot metal at certain periods. Some different types of these feeding heads are shown in Fig. 2. The size and position of these are governed more by acquired experience than by a fixed rule. Whilst on the question of feeding heads, it is advisable, when the casting has been poured, to pull the charcoal from the top of the crucible to the top of the head metal. This helps to keep the head metal hot and prevents skin formation whilst waiting for shrinkage. Also, whilst for small castings sufficient deoxidiser has been added, one sometimes finds that it is insufficient for larger types with slower rates of cooling. An indication of this state of affairs is when sparks, in fountain-form, come from the head, and the head afterwards begins to bleed and flow over.

Electrical Properties

Table I shows the conductivity of different samples of copper with varying amounts of silicon-copper added. Here it will be seen that samples No. 1 and No. 2 made from high-grade electrolytic copper give 90 per cent. with 2 ozs. and 88 per cent. with 2¼ ozs. of added silicon-copper to 100 lbs. of electrolytic copper. Nos. 3, 4 and 5 show the effects of adding 3 ozs. of silicon-copper to varying mixtures of high-grade and scrap copper, and No. 6 shows the conductivity of the scrap copper with 3¼ ozs. of silicon-copper added.

Contamination of Scrap

From a study of the conductivity figures, it will be readily understood that scrap heads and runners must be carefully separated from other metals, as a small amount of any of the other metals commonly used in the brass foundry will reduce the conductivity below the desired figure.

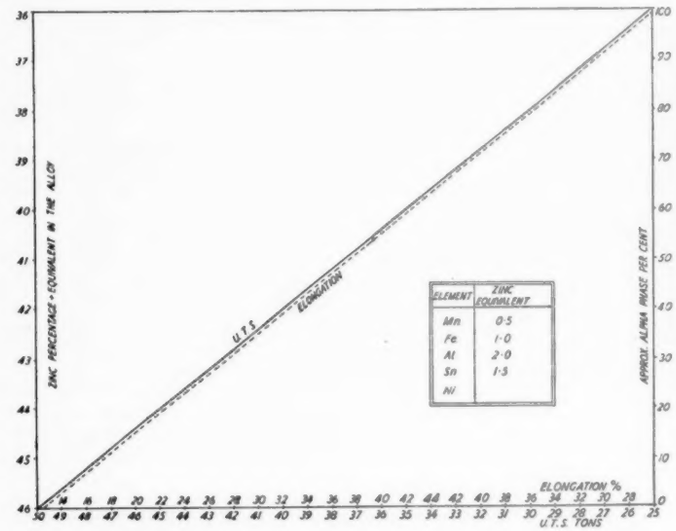

FIG. 3.—PHYSICAL PROPERTIES OF MANGANESE-BRONZE.

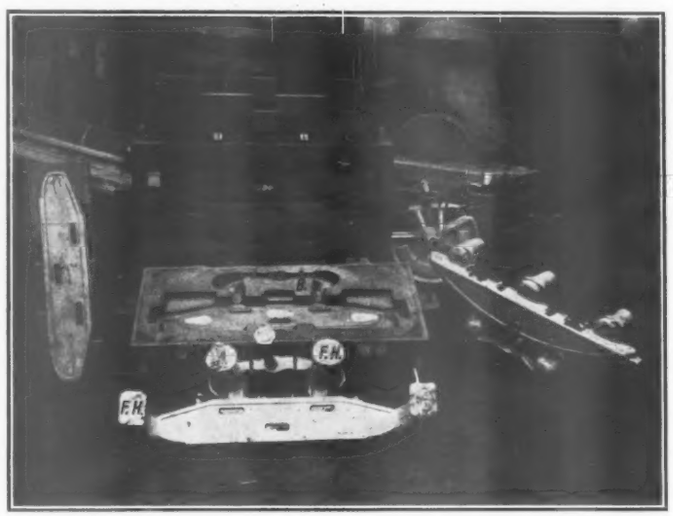

FIG. 4.—PATTERN, MOULD AND CASTING OF MANGANESE-BRONZE CROSS-BAR.

MANGANESE-BRONZE OR HIGH-STRENGTH BRASS

The chemical composition of manganese-bronze varies according to the physical properties required, and the foundry making the alloy. Usually, for the specifications up to 40 tons ultimate tensile strength, small amounts of manganese, iron, tin and aluminium added to the common 60-40 brass will give the result required. When a strength between 40 and 50 tons is required, it is found that probably the addition of a small percentage of nickel will give the desired results.

Alloying

Manganese-bronze can be bought in ingot form or made by using copper with the addition of special hardeners. Copper and zinc form a large percentage of a manganese-bronze alloy, and it is advisable to use high-grade copper and zinc of 99.95 purity. Manganese is usually added by means of a Mn-Cu hardener, consisting of 70 per cent. Cu and 30 per cent. Mn. Iron can be added in the form of ferro-zinc, ferro-manganese or a copper-iron-aluminium hardener. Nickel is added as cupro-nickel.

As there are such a large number of commercial alloys under various trade names, besides different alloys which have been published in the Press, no definite composition will be given, but it can be stated that the manganese-bronze and high-strength brass alloys are generally of the following character:—Copper, from 50 to 60 per cent.; tin, up to 2 per cent.; iron, from 0.25 to 3 per cent.; manganese, from 0.25 to 4.5 per cent.; aluminium, from 0.25 to 5 per cent.; nickel, from 0 to 4 per cent., and zinc remainder.

As a rapid change in physical properties is due to the variation in the proportions of the alpha and beta constituents in manganese-bronze, a careful control over the composition is necessary.

Fig. 3 shows a graph prepared from a large number of tests giving the approximate relation between the alpha and beta phase, zinc percentage, alloy equivalent, and the corresponding physical properties. In the inset are given the calculated zinc equivalents of the various elements used. In one type of practice these remain fairly accurate as long as the iron, manganese and aluminium do not exceed 3.5 per cent. each. It will be noticed that a figure is not stated for nickel, because during some recent experiments the addition of nickel to a beta high-strength brass has given very high physical results, and so long as the gamma constituent can be avoided, high-strength brasses containing copper, nickel, manganese, iron, aluminium and zinc can be regularly produced with physical properties averaging 46 tons U.T.S.

Nickel (according to Fig. 3) in the region below the 40 per cent. alpha, is an element which, in conjunction with a small percentage of aluminium and the other elements will probably in the near future produce some remarkable physical properties in high-strength brasses. From a number of tests indications are that nickel has a zinc equivalent figure similar to aluminium for calculation purposes when used in manganese-brasses containing Mn, Fe and Al, and having less than 40 per cent. alpha.

TABLE I.—*Conductivity Tests on Copper Castings.*

Sample no.	Restivity. Microhms per cm. cube.	Temp. Deg. C.	Conductivity. Per cent.	Remarks.
1 ..	1.90	18.2	90.0	2 ozs. Si–Cu added to 100 lbs. electrolytic Cu.
2 ..	1.94	18.2	88.0	2¼ ozs. Si–Cu added to 100 lbs. electrolytic Cu.
3 ..	2.17	20.0	79.5	3 ozs. Si–Cu added to 100 lbs. electrolytic Cu.
4 ..	2.56	20.0	67.5	3 ozs. Si–Cu added to 50 per cent. electrolytic Cu, 50 per cent. scrap Cu.
5 ..	2.60	20.0	66.4	3 ozs. Si–Cu added to 66 per cent. electrolytic Cu, 33 per cent. scrap Cu.
6 ..	3.21	20.0	53.5	3¼ ozs. Si–Cu added to 100 per cent. scrap Cu.

Melting

Carefully controlled melting practice is necessary, and various types of melting plant may be used. For anyone not very familiar with the characteristics of the metal, it is suggested they first try the alloy in the crucible, as this form of melting is probably the easiest to control. In the flame type of furnace the flame should be kept slightly oxidising. The melting procedure can be as follow:—First melt the copper, together with the various hardeners of Mn-Cu, cupro-nickel and iron hardener, and when molten add the aluminium and zinc. Various fluxes may be used, and the choice is extensive, but a covering of charcoal (salt, borax and ground glass) is a very good flux during the early part of the melt. When the first part of the mixture is molten, a covering of anthracite coal is a suitable protecting flux whilst the other elements are added, if the alloy is in an open-flame type of furnace.

Runners and Heads

Fig. 4 shows the pattern, mould and casting of a manganese-bronze cross-bar. Here it will be seen that the casting is poured from the bottom; whenever possible, castings in this alloy should be poured from the bottom. Any agitation of the metal in the runner basin or in the runner creates a scum or dross. This is prevented from entering the mould by placing a bridge in the ingate, B. It is always advisable to use a skim gate for manganese-bronze castings, and for some large moulds two or three skim gates are placed in the flow of the metal before it is allowed to enter the casting. Coupled with the use of skim gates, the horn gate is used to allow metal to enter at the lowest point of the mould, and these can be seen at H in Fig. 4.

Feeding

To avoid unsoundness due to the high liquid or solidification shrinkage, voluminous feeding risers must be placed on the heaviest sections. Some of these can be seen at FH, Fig. 4. For certain types of castings a combination of chills placed at heavy sections and feeding heads can be used. Copper chills have been found to give good service.

Whilst it is considered advisable to run the casting at the bottom, there are instances where a second runner is advantageous. Fig. 5 shows a liner bush approximately 16 in. outside diameter, 12 in. inside diameter, and 4 ft. high. The first runner is at the bottom, shown at *a*, but as this is a heavy section, and to ensure dense metal, it was necessary to place a chill round the outside. If the casting were completely poured by the bottom runner, a hot spot would be maintained and segregation shrinkage would occur. To avoid this, a horn runner is placed at *b*, metal being poured down it when it is judged sufficient has entered the mould through *a*. When *b* runner is used *a* runner is stopped up with sand to prevent any rising metal.

(To be continued.)

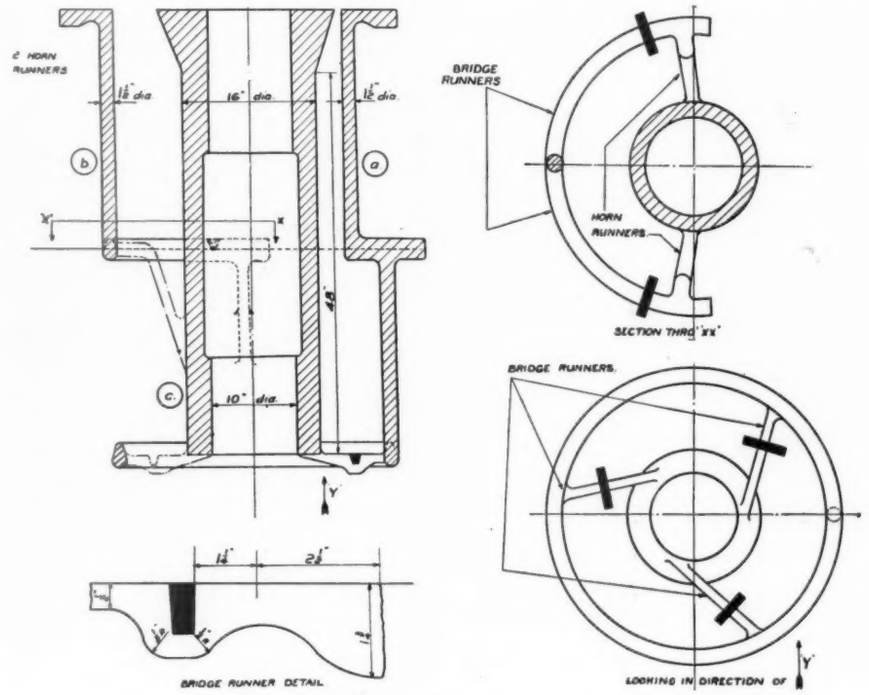

FIG. 5.—METHOD OF RUNNING A LINER BUSH IN MANGANESE-BRONZE.

Catalogues Received

Electro-Magnetic Equipments. The receipt of the latest publication from the Rapid Magnetting Machine Company, Limited, Magnet Works, Lombard Street, Birmingham, 12, brought back memories of a visit we paid to their works a few months ago to inspect the very magnet shown on the front cover. This illustrates eight men magnetically suspending themselves from it. There are a dozen or more applications of magnets illustrated, such as for handling scrap, treating brassfounders' ashes, vitreous enamelling, and, of course, the latest model for treating foundry sands in a mechanised system.

Portable Heaters. The Riley Stoker Company, Limited, Palace Chambers, Bridge Street, Westminster, S.W.1, in a well-presented four-page leaflet, describe a portable heater they have designed and are marketing. Though it uses bituminous coal as fuel it creates no smoke, and will heat a 40,000 cub. ft. building, with the proviso that the shop is in no way abnormal. The stoking is automatic, whilst the forced-draft air supply is electrically controlled from a lead off a wall plug. Whether these portable heaters have technical applications is not stated in this publication.

Iron and Steel Institute

A preliminary notice issued by the Iron and Steel Institute, regarding the Autumn Meeting to be held jointly with the Institute of Metals in New York on October 3 and 4, states that arrangements have been made with the Cunard White Star Line for accommodation to be reserved for members wishing to travel direct to New York in s.s. "Samaria" sailing from Liverpool on Friday, September 23, and due to arrive in New York on the morning of Sunday, October 2. By special agreement with the shipping company the call at Boston will be omitted. Members other than those visiting Canada are strongly recommended to sail in this ship. The r.m.s. "Queen Mary" is due to sail from Southampton on Wednesday, September 28, and to arrive in New York on the morning of Monday, October 3, in time for the opening session of the meeting in the afternoon of that day.

After the meeting in New York a tour will be arranged in order to enable members to visit Washington, Pittsburgh, Cleveland, Detroit, Chicago, Boston, and other cities.

Works Visits.—Opportunities will be given for visits to numerous important iron and steel works, to works of non-ferrous interest, metallurgical laboratories and other industrial and scientific establishments.

Social Functions.—The American Institutes have expressed the intention of entertaining members and ladies at a number of evening and other social functions. In addition opportunities will be provided for sightseeing and for visits to places of historical interest and natural beauty.

Programme for Ladies.—Ladies are cordially invited to participate. A special programme of excursions and visits is being prepared, and every endeavour will be made to make this as interesting and attractive as possible.

An outline of the programme appeared in our issue for September 16, 1937, and the arrangements now issued in greater detail and still of a preliminary character are substantially the same.

New Electric Furnace for Research

A new furnace for heating metals without contamination up to about 2,500 deg. C. has been devised by a metallurgist at Harvard University, Cambridge, Mass., and consists of a small cylindrical crucible or metal cup made of tantalum, lined with thorium oxide and about ½-in. in dia. and height. In operation, the substance to be melted is placed in the crucible which is mounted between two filament wires in an air-tight cylindrical hood from which air is evacuated by a powerful vacuum pump. An electrical potential of 2,500 volts positive is then applied to the crucible, causing an electron flow from the filaments to the crucible. Kinetic energy of the electrons striking the crucible is converted into heat, rapidly raising the temperature. In tests, iridium has been melted at 4,230 deg. Fah., platinum at 3,200 deg. and palladium at 2,790 deg., indicating the present equipment can be used to melt all but six of the 55 known metallic elements, namely carbon, tungsten, rhenium, tantalum, osmium and molybdenum. Although electron bombardment has been utilised for intense heat before, this is its first application to metallurgy, it is claimed.—"Steel."

Indian Pig-iron for Japan

It is reported that the Indian Iron & Steel Company has booked a new contract with Japan for a further 100,000 tons of pig-iron, at a price of Rs. 48 per ton, ex works, as against Rs. 70 paid under the last contract. Pig-iron exports from India to Japan have been diminishing, and in the first nine months of the last three fiscal years, *i.e.*, April to December, were 270,000 tons in 1935, 240,000 tons in 1936 and 216,000 tons in 1937.

Large Electric Furnace for Jarrow

The accompanying illustrations show the Tagliaferri electric furnace which has been installed at Jarrow-on-Tyne for Jarrow Metal Industries, Limited. The furnace is of 15/17 tons capacity, having a transformer of 4,000 k.v.a. It has been built complete with removable hearth arrangement, folding platform, automatic charging buckets and graphite electrodes, the latter being 14 in. dia. The power for operating the furnace has been taken from the North-Eastern Electric Supply Company.

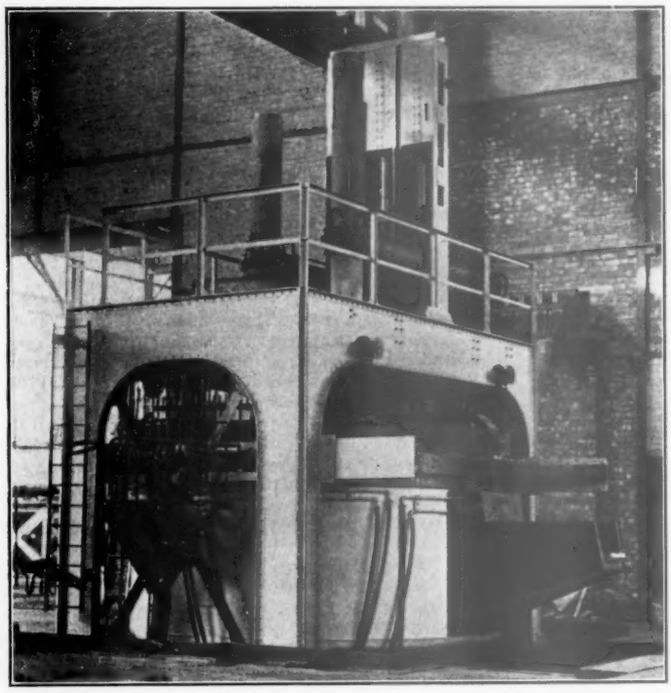

FIG. 1.—FURNACE IN NORMAL POSITION.

FIG. 2.—FURNACE IN TAPPING POSITION.

VIEWS OF 15/17-TON ELECTRIC FURNACE AT THE WORKS OF JARROW METAL INDUSTRIES, LIMITED.

The Tagliaferri regulator employed is one which has been designed not only from the electric-furnace point of view, but from the point of view of a practical steel-maker, and it has been the aim of the designer not only to reduce the number of moving parts to an absolute minimum, but to make the whole of the equipment of such simple design that the average maintenance engineer has no difficulty in making normal working adjustments. Furthermore, it has been designed to eliminate as much equipment as possible, particularly round the furnace itself. By using hydraulic rams for electrode raising, lowering, tilting, opening of the door, etc., the actual mechanism is reduced to the simplest.

The Tagliaferri regulator for the three electrodes is contained in a box approximately 30 in. by 10 in. by 8 in. In this box is the whole of the mechanism controlling the three electrodes. This represents a remarkable saving in floor space compared with the usual regulating equipment. The operation of the Tagliaferri regulator is on the same principle as the movement of an ammeter; as the current increases, an armature is attracted to the pole pieces of a stator. This armature is attached to a spindle which rotates the servo oil valve and opens and releases the pressure on the servo ram which, due to a compression spring, allows the hydraulic valve to apply the pump pressure to the rams of the electrodes and causes them to rise. Should the current fail, the armature moves away from the pole pieces, closes the servo valve, which causes the pressure from the servo equipment to build up on the servo ram, and closes the hydraulic valve which connects the rams of the electrodes to atmosphere. This allows the electrodes to fall. The whole of the servo mechanism operates under oil and is operated by a small oil pump. In addition to the current coil for each electrode, a further coil is added which is connected to earth at the bottom of the furnace, so that should, at any time, the electrodes travel down to the bottom of the furnace and cause a current flow between the electrodes and the bottom of the furnace, these relays cause the electrodes to rise. If, at any time, the electric power fails, the servo valves immediately open and cause pressure to be applied to the electrode rams from an air vessel which, in turn, causes the electrodes to rise clear of the bath, thus preventing any possibility of damage. Each servo equipment is of such design that it can be quickly removed and replaced within about a quarter of an hour.

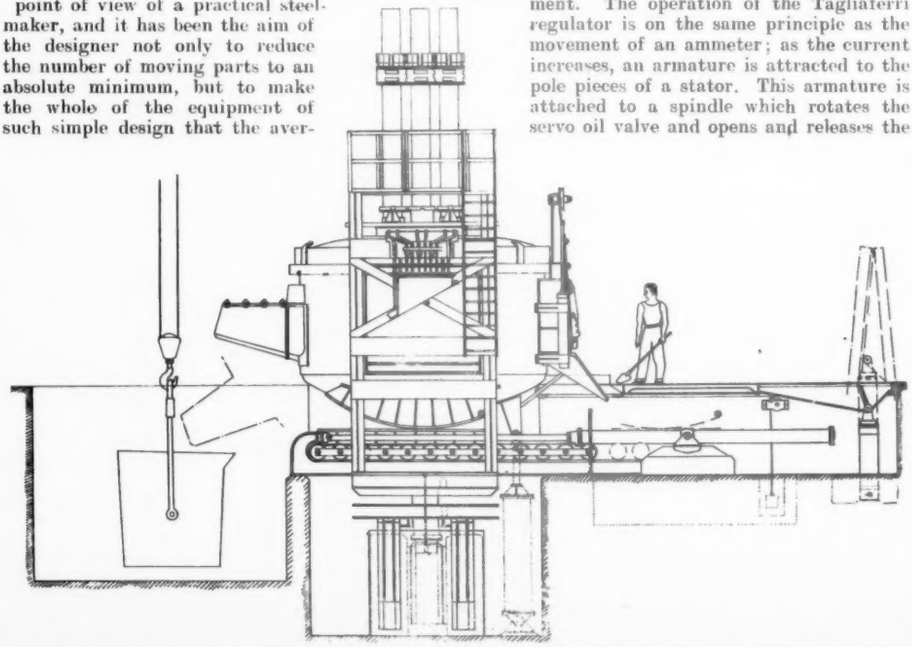

FIG. 3.—SECTIONAL VIEW OF 15/17-TON ELECTRIC FURNACE SHOWING HYDRAULIC TILTING GEAR.

The Tagliaferri regulator offers the additional advantage that due to its rapidity of operation electrode consumption is reduced by practically 10 per cent. as compared with the electrically-operated control.

The furnace at Jarrow-on-Tyne will be capable of dealing with a maximum output of approximately 500 tons per week working a 24-hr. day seven days per week, and various types of steels and alloys will be manufactured, all of which are to a definite and given analysis to meet the many requirements necessary to feed the various departments of Sir W. G. Armstrong Whitworth & Company (Ironfounders), Limited, and Jarrow Metal Industries, Limited, coupled with the production of tube billets for the Jarrow Tube Works.

Metalectric Furnaces, Limited, of Smethwick, Birmingham, built and installed the furnace in question, being licensed to control and build the Tagliaferri furnace in Great Britain and the British Colonies.

Patternmaking for the Light Castings Industries*

By ROBERT R. SHAW

When a patternmaker is confronted with a drawing from which a pattern is required, he should, if possible, find out for what purpose the casting is intended, so that he may determine whether great accuracy be required or not. For example, it would be absurd to work to, say, the second decimal place in making a furnace bar. He should also ascertain how many castings are likely to be required from the pattern, so that he may make his pattern in hard wood if a large number of castings are required and, of course, in yellow pine if only a small number are demanded. This information would also guide him as to the advisability of making a pattern-plate, in which case he would require to start with three contractions. All this information must be available to the patternmaker before ever he puts a saw to the wood, if he is to make the pattern in the most economical manner.

Choice of Materials

Having obtained such information he must next determine what is the most suitable material in which to execute the work, envisaging wood, plaster, and tin-lead alloy. Experience and experience alone can determine this point, and in some cases two equally competent patternmakers may differ in their views as to what is the most suitable material; but, generally speaking, there are certain salient features which are indicative in this respect. For instance, if the job under consideration be suitable for stucco—irrespective of its cross-section—it must (1) all run in parallel lines; (2) must be symmetrical about a definite centre, and (3) it may be an ellipse.

There is a variety of combinations of these, in which case the patternmaker must use his own ingenuity as to how best to obtain the combination for a particular design, but, broadly speaking, if a pattern conform to one of these three types, it can be made successfully in stucco.

In sweeping up a pattern in stucco, the first step is to have available a perfect surface board, because any irregularity in the board is bound to be reflected in the pattern. The drag of the box in which the job will be moulded must fit the board. It is negligence to find that after a job is made there is no box in the foundry which fits the board. Hammering is undesirable where a fragile stucco pattern is concerned.

Making the Strickle

All strickles must be sufficiently robust to prevent vibration when the stucco begins to expand. Templates are made in sheet zinc, and the first template which represents the saddle or block is cut to the inside contour of the job. The second and subsequent templates are cut to the block plus the thickness of metal, that is, the outside contour of the job and the difference between the first and the second is the pattern proper. These templates are cut and accurately placed against each other and fixed with a drop of solder at the corners. They are then mounted on the strickle in such a way that the first can be removed from the second without the second being removed from the strickle. This is accomplished by having some of the wood screws common to both templates, while others are only holding through the second template. This is a very important step because one can never obtain the same degree of accuracy if the templates are mounted on the strickle individually.

Stucco, plaster of Paris, and alabaster are three names in common use for the same substance. Chemically, it is a hydrated form of calcium sulphate, and "Note-well" stucco is the powder form in which it is received at the author's works. Once it is added to water it ceases to be stucco and absorbs a molecule of water to become gypsum, so that it would be more correct to talk about a gypsum pattern than a stucco pattern. The chemical change which takes place when water is added to stucco is accompanied by an exothermic reaction. When the whole mass sets, a great deal of steam is evolved, but what is important from the point of view of the patternmaker is that this evolution of heat is always accompanied by an expansion.

If the job be large this expansion must be allowed for. There is no better way of overcoming this difficulty than by making a V-shaped parallel piece of wood the entire length of the job and fixing it to the board by wood screws, the heads of which are filled up flush with tallow, and the whole of the V-shaped strip heavily coated with tallow. By this means it is possible to allow the stucco to expand along its entire length and still adhere firmly to the board. If no provision be made in this respect the stucco block will either twist the board or leave the board.

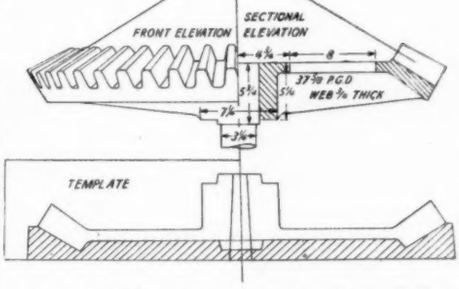

Fig. 1.—Front and Sectional Elevations of Bevel Wheel, and Method of Sweeping.

Reference has only been made to lineal expansion, as it is usually the greatest, but with large sectioned jobs provision must be made for expansion both in breadth and thickness. This is most easily surmounted by making a rough template in wood, ¼ in. less than the finished size, so that the block may be run up in two stages and time given for expansion to cease between each stage.

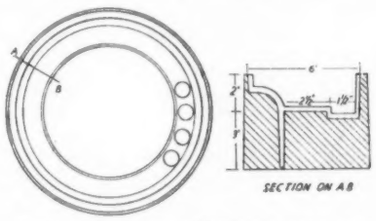

Fig. 2.—Circular Pattern made in Stucco.

Stucco Bevel Wheel Pattern

Fig. 1 shows a bevel wheel. The upper view shows on the left a front elevation, and on the right a sectional elevation. A blank pattern, *i.e.*, a pattern where the teeth are machine-cut from the solid casting, can be very successfully made in stucco for this class of work, if only a limited number of castings be required. The method of sweeping is self-evident by reference to the bottom sketch. The webs are made in wood and fitted to the pattern so that they will work loose in the top part. The 8-in. windows as shown in the sectional elevation are cut from the solid stucco. A pattern of the size shown in the sketch, viz., 37⅝ in. P.C.D., can be made in stucco for a fraction of the cost of a wood pattern, and its accuracy leaves nothing to be desired.

A Circular Pattern

Fig. 2 shows a circular pattern which could not be made as a shell pattern in anything other than stucco. The great difficulty here was to get the flange 3 in. deep, ¼ to ⅜ in. thick, and 21 in. diameter. The block was run in two pieces, which were swept up simultaneously, and after the entire pattern was made the outside block was cut in five equal portions, which were withdrawn longitudinally while the pattern was withdrawn from the other half of the block vertically.

Fig. 3 is an example of sweeping a pattern in a vertical position. The great advantage of this method is that the template is always working radially to the centre.

Stucco Core-Boxes

Stucco has also a very convenient application in the making of core-boxes and it can be stated that the stucco core-box is the most accurate type of core-box made. Fig. 4, for example, shows how a split pattern can be made the exact representation of the core. From this pattern a two-part core-box is made in stucco, exactly as a two-part mould is made in sand. With this method the patternmaker is working with a positive shape all the time, and can therefore obtain greater accuracy, where complicated core-boxes are concerned, than he could ever hope to attain if cutting from the solid wood. These remarks do not, however, apply where machinery such as an auto wood miller is used.

Wood Shell Patterns

The making of patterns in wood is by far the largest section of the patternmaking trade, and to do the subject justice would require a separate Paper, so observations will be confined to the making of shell patterns. A shell pattern is identical in appearance to the casting itself and differs from the block pattern and core-box in so far that there are no coreprints and, incidentally, no core-boxes. The whole is moulded in greensand and the pattern leaves its own core. It has frequently been said by ironfounders, particularly in the West of Scotland, that the block pattern and core-box make the best job, and such may be true for certain types of work.

Each job, of course, must be judged on its own merits, but most certainly for some types of light work a shell pattern in the hands of a Falkirk moulder will give a casting with a better finish and dimensionally more accurate than any block pattern and core-box. The making of moulds from shell patterns requires a higher degree of moulding skill than is usual with the block pattern and loose pieces, drawbacks, etc., worked in a two- or three-part box is the usual practice.

A shell pattern of complicated design and no more than ⅛ in. thick must always be built on a block and moulded on it. The block is made and finished to the inside size with $\frac{1}{16}$ in. clearance all round. This is covered with a sheet of paper and the pattern is built on it, the paper serving a dual purpose in so far as, when it is removed, the correct clearance is left to allow the block to be withdrawn from the pattern when the drag is rammed up, and it also prevents the glue which must be used to build up the pattern from sticking to the block. In the case of a pattern ⅛ in. thick one must implicitly rely on glue as a means of holding it together, as only the finest pin could be used for a nail.

Tin-Lead Patterns

If camber be a factor, the tin-lead pattern certainly overcomes the difficulty with the minimum of trouble. The fabricating of patterns in

* Given as a Presidential address to the Falkirk Section of the Institute of British Foundrymen.

tin-lead alloy forms the major portion of the work in most light-casting patternshops. Tin is soluble in lead to the extent of 18 per cent. at an elevated temperature only, but as the temperature falls the solubility decreases until at room temperature it is almost insoluble. Thus all the alloys of the series from 99 per cent. tin on the one hand to 99 per cent. lead on the other can be considered as forming a eutectiferous series with the eutectic occurring at 63 per cent. tin: 37 per cent. lead.

The eutectic alloy has no pasty range in changing from the liquid to the solid state, and thus the probability of a drawn casting due to liquid shrinkage is reduced to a minimum. A 63 per cent. tin alloy, however, is much too expensive for industrial purposes; therefore an alloy of 80 per cent. lead and 20 per cent. tin answers the purpose in every aspect. This alloy melts at a temperature of around 210 deg. C., so that it may be conveniently melted over an open fire

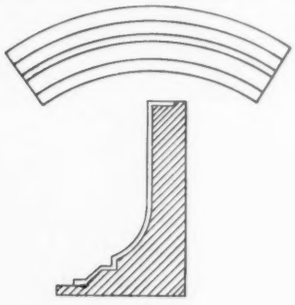

FIG. 3

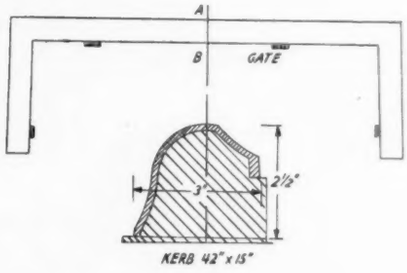

FIG. 5

and is sufficiently fluid to be cast as thin as 0.1 in. If the alloy is heated too far above its melting point a familiar brown crust is observed to form on the top and is—very wastefully—skimmed off by the patternmaker and thrown amongst the ashes. This brown crust is really the metal having oxidised, forming stannic oxide and litharge, and may be reduced to its elements again by heating still more strongly.

Moulds suitable for casting tin-lead must be faced with a special sand which is very high in alumina and very fine in texture. If ordinary floor sand be used the surface tension of the metal is so low and the oxide such a powerful flux that the searching action of the metal renders the surface of the casting so rough that the time required for the patternmaker to dress it is out of proportion to that required if the casting had been made in the proper facing sand. A small pattern moulded in tin-lead alloy by a skilful patternmoulder need require little more than a clean up with a file.

It has often been observed that a patternmaker who could be classified as a first-class craftsman in wood often falls short when asked to execute a pattern in tin-lead alloy, and no doubt such is often the case. The converse of this case, however, is absurd. One cannot get a man who is efficient in tin-lead who is not also efficient in wood, because invariably it is found in tin-lead alloy practice that the board and saddle on which the tin pattern is built must be made most accurately in wood.

The first step in making a tin-lead alloy pattern is as in the previous case with stucco; a perfect surface board must first be made. This board must next be blocked to fit the tin pattern, and this must be regarded as a branch of wood patternmaking which calls for the greatest accuracy, because any irregularity in the block will ultimately be reflected in the pattern. The block should be fixed to the board with screw nails only. Driving nails should never be used, because if the pattern should be found to require camber in order that a straight casting should be obtained, it is only a matter of unscrewing the block, sweeping the board to the convex as much as the trial casting was concave, then screwing the block to the cambered board. This will generally be found to be a more accurate method than to camber the block.

The building of a tin-lead alloy pattern on a block is always accomplished by soldering a

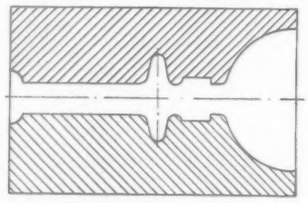

FIG. 4

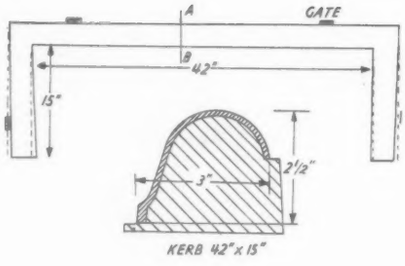

FIG. 6

number of small sections together. The length of these sections should never be more than, say, 10 in., so that a very accurate casting can be made in a small moulding box. These small castings are all cleaned up separately, fitted to the block, and soldered together. The small pattern can either be in wood, plaster or even modelling clay, depending on the nature of the job.

Another type of pattern frequently executed in tin is a pattern where a certain design repeats itself throughout the entire job. In this case the smallest size which will include the whole design is first made, and the requisite number of castings to give the size of pattern is made from it. These are all soldered together. Thus every one is exactly as its neighbour, such as, for example, a diamond mesh grating.

Camber

Fig. 5 shows a pattern for a kerb. A section of AB is first of all swept up in stucco, about 10 in. in length, and this is given to the patternmoulder to make the requisite number of castings in tin-lead alloy. The patternmaker first makes a true surface board, and then a block as shown in Fig. 5. The pattern is built on this block and finished in a perfectly flat manner. If it was not for camber this pattern could quite well be made in stucco, but as the camber on such a job cannot possibly be predetermined, one is forced to make it in a tin-lead alloy. It has long been a personal contention that to understand camber fully, knowledge of how metals crystallise and the various resultant phases is desirable.

Considering the kerb under two different systems of gating, it will be appreciated that if the gates with yankee runners be placed as shown in Fig. 5, the legs would require to be set at an angle to the lintel in order that a straight casting should result. If, however, the gates be as shown in Fig. 6, then the angle of the legs would require to be reversed.

The nature of the camber depends on several factors. It depends (1) most of all on the design; (2) on the composition of the metal; (3) on the casting temperature; (4) on the location of the gates, and (5) perhaps to a lesser extent on the ramming. Finally, to reduce camber troubles to a minimum the use of a very soft iron, associated with a very high casting temperature, is advocated.

Publication Received

Proceedings of the American Society for Testing Materials, 1937. Published in two parts by the A.S.T.M., 260, South Broad Street, Philadelphia, Pa. Price $5.50 each in stiff paper cover; $6 cloth bound; $7 in half-leather.

The 1937 Proceedings of the A.S.T.M. are published in two parts, Part I comprising committee reports (with appended Papers) and new and revised A.S.T.M. tentative standards, whilst Part II gives all technical Papers, including the Marburg Lecture. Included in Part I, which contains no less than 1,365 pages, are reports of 45 committees outlining important standardisation and research work. This part also includes some 118 specifications and tests prepared for the first time in 1937 or revised. Nine of the reports involve ferrous metals, including steel, yield point of structural steel (final report), wrought iron, cast iron, corrosion, malleable iron castings, iron-chromium-nickel and related alloys, fatigue of metals and effect of temperature on the properties of metals. The latter has appended items covering discrepancies in load-carrying abilities of carbon steels at 450 deg. C., and prolonged creep tests on certain steels. Seven reports involve non-ferrous metals, including copper and copper alloy wires for electrical conductors, non-ferrous metals and alloys, corrosion of non-ferrous metals and alloys, electrical-heating and electric-furnace alloys, copper and copper alloys, die-cast metals and alloys and light metals and alloys. This section includes appended items on brass die-castings, a study of die-design changes for test-bars, modulus of elasticity of aluminium alloys, and data on tests of oxide coatings on aluminium.

Forty-seven technical Papers are published in Part II (707 pages), and in addition the Edgar Marburg Lecture on "Plastics—Some Applications and Methods of Testing" is included. An important feature of this volume is the extensive discussion of the numerous Papers. These Papers relate to metallic materials, including weld metal, several on cast iron, analysis of the Brinell hardness test, fatigue properties of non-ferrous sheet metals and of metals used in aircraft construction. Three Papers pertain to the use of metals at elevated temperaturs.

SIR ROBERT HADFIELD, BT., F.R.S., has been awarded the Trasenster medal and diploma for 1938 by the Association des Ingénieurs de Liège. This award has previously been made only to M. Henry Le Chatelier, the well-known French scientist and metallurgist, and five other distinguished scientists of various nationalities.

Corrosion-Resisting Cast Iron—Its Production and Use

By FRANK HUDSON

(*Continued from page* 254.)

AUSTENITIC CAST IRON

All types of austenitic cast iron are not necessarily corrosion resisting, and accordingly remarks relative to this section will deal essentially with those compositions known to have a marked resistance to corrosive attack, such as the irons containing over 14 per cent. nickel together with appreciable amounts of copper and to a lesser degree chromium, in addition to the other elements normal to grey iron.

As long ago as 1799, nickel was employed to improve the corrosion resistance of cast iron. In that year Hickling[7] took out a Patent for the manufacture of cast-iron hollow vessels containing up to 25 per cent. nickel, but it was not until comparatively recent times that the full properties of nickel additions were recognised in this direction. Following the investigations of Arnott in this country, together with the work conducted by Merica and Vanick, of the International Nickel Company, in the United States, the austenitic irons known first as Nimol and later as Ni-Resist were introduced just prior to 1930. Mention might also be made of the valuable development work since conducted by Everest. Unlike the high-silicon irons, austenitic cast iron is readily machinable, is not unduly difficult to handle in the foundry and possesses a range of useful mechanical properties which permit it to be used in a wide range of engineering applications.

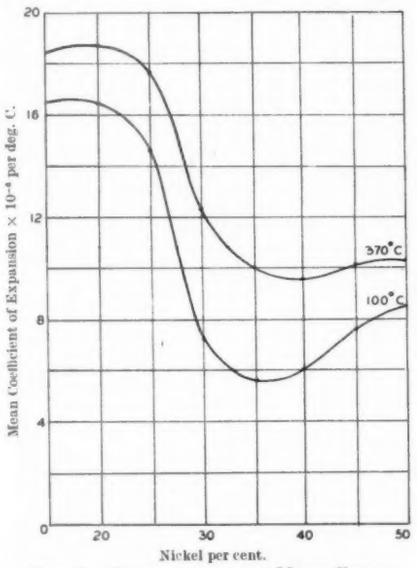

Fig. 2.—Curves showing Mean Coefficients of Expansion of High-Nickel Cast Irons from Room Temperature to Temperature Indicated.

Composition and Physical Properties

The typical and most widely used of the irons in this group is that known as "Ni-Resist," having a composition within the following limits:—

	Min. Max.	Recommended.
Total carbon ..	2.5 to 3.0	2.75 per cent.
Silicon	1.4 to 1.8	1.6 „
Manganese	0.8 to 1.5	1.0 „
Sulphur	— 0·1	0.07 „
Phosphorus	— 0.4	0.2 „
Nickel..	13.0 to 16.0	14.5 „
Copper	6.0 to 8.0	7.0 „
Chromium	1.5 to 2.5	2.0 „

The recommended composition given above applies to castings up to 1 in. in thickness. Where heavier sections are encountered it is advisable to increase the nickel content by a further 2 or 3 per cent. in order to ensure free machinability. In certain cases where the presence of copper may prove detrimental, for example, in food-handling equipment or for resistance against alkalis, this element may be omitted, in which case the nickel content must be increased by an equivalent amount. Chromium is included in order to increase strength and hardness, but the upper limit given above should not be exceeded because excess chromium, without an increase in the nickel content, again causes machining difficulties.

In certain cases compositions with nickel increased up to 40 per cent. and with chromium up to 15 per cent. have been used to meet specially severe conditions. An important characteristic of the austenitic irons containing between 30 and 40 per cent. nickel alone is their property of having a low coefficient of expansion in conjunction with good corrosion resistance, as shown in Fig. 2. This combination of properties has proved most useful in certain types of industrial equipment having to operate under heat as well as under corrosive conditions.

Within the usual range of composition previously mentioned, Ni-Resist has the following physical properties:—Density, 7.5 to 7.6; tensile strength, 13.0 to 17.0 tons per sq. in.; elongation, 0.5 to 1.0 per cent.; Brinell hardness, 140 to 200; coefficient of expansion per deg. C., 0.000018; thermal conductivity, 0.08 c.g.s. units; melting point, very similar to grey iron; contraction, $\frac{5}{32}$ in. to $\frac{3}{16}$ in. per ft.

It will be observed that the strength of this material is much higher than the silicon irons previously discussed, and a certain measure of ductility is available which imparts toughness and shock resistance. All the normal* austenitic irons are non-magnetic, and this property affords a simple test for readily distinguishing them from ordinary and other corrosion-resisting irons. If the above range of properties is to be maintained it is essential that a combination of higher carbon and silicon contents than those given should not be present. For example, experience indicates that when the total carbon and silicon contents exceed 3.0 per cent. and 1.9 per cent. respectively there is every possibility of the tensile strength falling well below the values given down to around 8.0 tons per sq. in. Furthermore, with this class of iron low total carbon very definitely assists the founding of castings having intricate or uneven design, minimising shrinkage troubles and porosity.

These results tend to be confirmed by the observations of Russell,[8] who at the same time points out that with low-carbon austenitic iron trouble may be experienced with hardness in casting sections of $\frac{1}{4}$ in. and less. This can be overcome by two methods:—(1) Increasing the silicon content, and (2) heat-treating the castings by soaking for $\frac{1}{2}$ hr. at 850 deg. C. This same investigator also states that the presence of low carbon reduces the ductility to some extent, and if this property is of importance around 3.0 per cent. carbon should be employed.

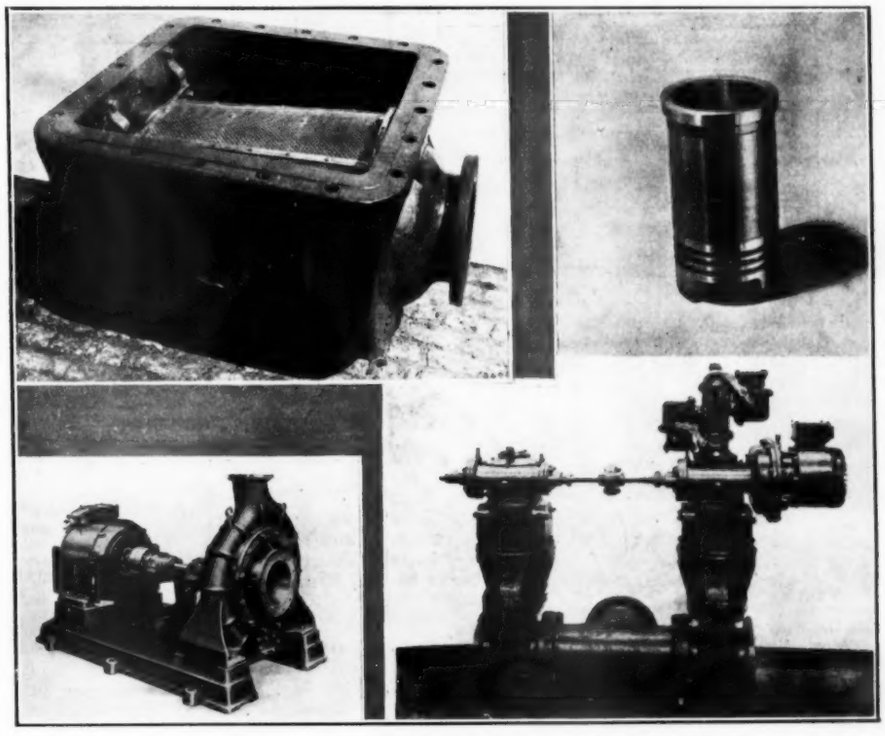

Fig. 3.—Typical Applications of Austenitic Cast Iron.

Top left: Glenfield Strainers (G. N. Haden & Sons, Limited).
Top right: Automobile Cylinder Liner (British Piston Ring Company, Limited).
Bottom left: Stuff Pumps for Paper Industry (Mather & Platt, Limited).
Bottom right: Glenfield Control Valves for Centrifugal Pumps (G. N. Haden & Sons, Limited).

Production Methods

Austenitic cast iron may be melted in practically any type of furnace capable of melting iron. The best results are, however, obtained by the

* Austenitic irons with nickel over 25 per cent. show increasing magnetic susceptibility.

use of crucible, reverberatory, rotary or electric furnaces. Cupola-melting is not too satisfactory unless a considerable tonnage can be handled at the one time, and even then very great care must be taken to prevent dilution of the first and last charge with ordinary iron. It is usual to place a double or treble coke charge at the beginning and end of the special iron to minimise this trouble.

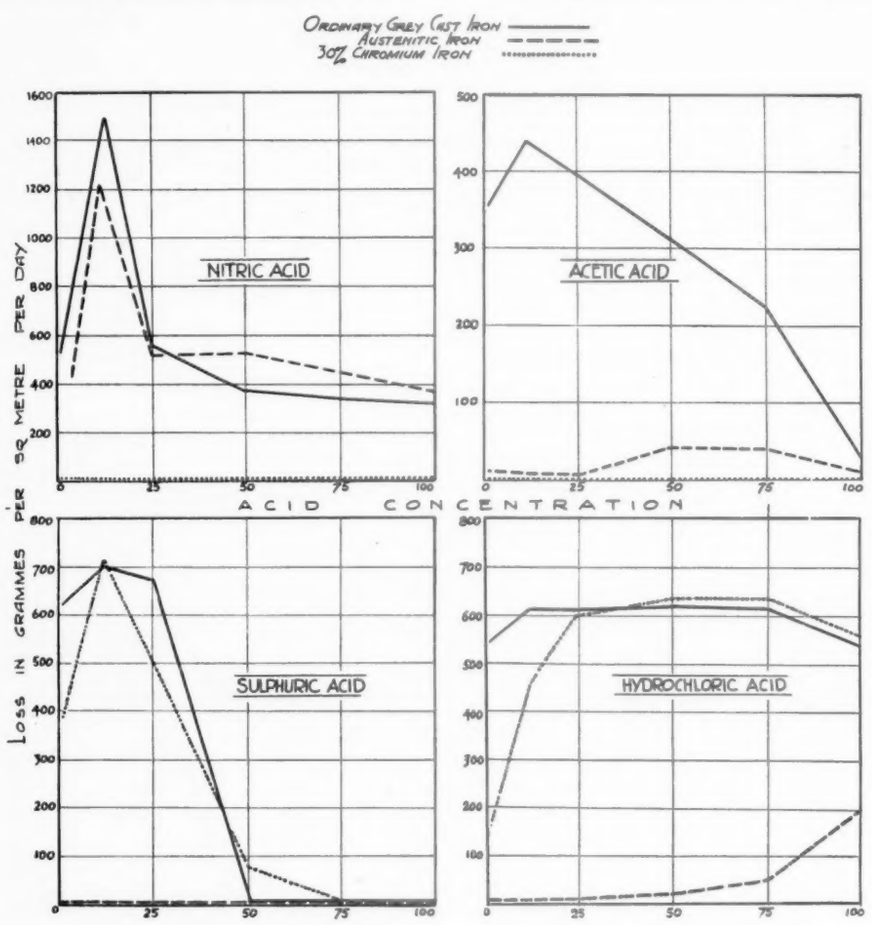

Fig. 4.—Graphs showing Degree of Corrosion of Grey Cast Iron, Austenitic Iron and 30 per cent. Chromium Iron in Aerated Solutions of Sulphuric, Hydrochloric, Nitric and Acetic Acids at 60 deg. Fah.

For the majority of founders the most economic results are obtained on the whole by melting in either crucibles or the oil-fired rotary furnace. Very successful results have also been obtained by melting a concentrated alloy containing all the nickel, copper and chromium in one or other of the two furnaces immediately mentioned and diluting this in the ladle to the correct amount by additions of ordinary cast iron of suitable composition from the cupola. This is particularly useful in producing the larger casting sizes, and it becomes possible, for example, to manufacture jobs weighing 16 cwts. from, say, a 4-cwt. Morgan tilting-crucible furnace.

The bulk of the austenitic iron produced consists essentially of an alloy of Monel with cast iron in conjunction with the addition of chromium. To simplify manufacture a special ingot known as N.C.C. pig* is available which has the following approximate compositions:—Nickel, 56 to 58 per cent.; copper, 24 to 26 per cent.; chromium, 8 to 9 per cent.; carbon, 0.5 per cent.; silicon, 0.5 per cent., and iron, balance. The use of one part of this alloy to three parts of a base iron containing 3.3 to 3.5 per cent. carbon; 2.0 per cent. silicon; 1.0 per cent. manganese; 0.3 per cent. phosphorus, plus a small addition of ferro-manganese, readily gives a very satisfactory composition. It is good practice to add half of the ferro-manganese with the N.C.C. pig in the furnace and the remainder after the alloy is molten. Theoretically, austenitic cast iron should not require de-oxidation, but little information is as yet available on this point, and it may be beneficial, as outlined above, to use a portion of the ferro-manganese addition for this purpose.

Returned scrap should be used with discretion, and normally it is advisable to restrict the amount used to about 25 or 30 per cent. of the total charge. Much will depend, however, in this direction upon the melting methods employed and the type of castings being produced. The author has employed 100 per cent. scrap with very great success for castings such as pump rams where a fair measure of hardness is a decided benefit. It should be noted, however, that the machining operation on such castings is relatively simple. In the majority of cases excessive use of returned scrap tends to lower the total carbon content to such a degree as to prevent free machining being obtained.

Technique in moulding and pouring austenitic irons is slightly different from that normally employed for ordinary grey iron. It is advisable to use somewhat heavier gates and risers and to pour fairly hot at temperatures between 1,300 and 1,350 deg. C. For further practical information on this subject reference should be made to a Paper given by Russell* in 1934. Care should be taken when fettling castings to remove gates and risers by cutting rather than by knocking them off with a hammer, as due to the toughness of the material there is a tendency for gates and risers to "break in." Notching or necking risers to facilitate removal, whilst being applicable to the high-silicon irons, is not recommended for the production of austenitic castings, as this restricts feeding action to some extent. The moulding sands normally used for cast iron are quite suitable for alloys in this group, but care must be taken if chaplets are required to make these in austenitic iron or, alternatively, in Monel. Patterns as for ordinary iron may be employed for small castings, but for larger sizes it is desirable to make suitable allowances for the greater shrinkage of this material. In the majority of cases an allowance of $\frac{5}{32}$ in. to $\frac{3}{16}$ in. is desirable.

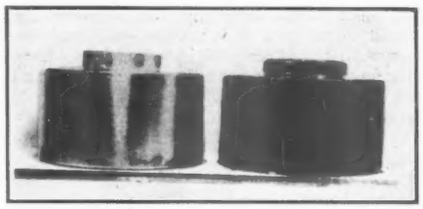

Fig. 5.—Appearance of Roller Sections after Immersion for 2 years in Water. *Left*: 30 per cent. Chrome Iron Alloy. *Right*: Ordinary Grey Iron.

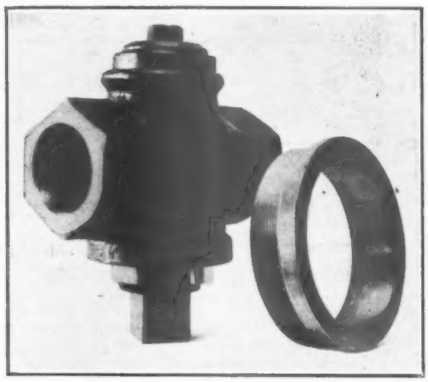

Fig. 6.—Plug Cock and Valve Face in 30 per cent. Chrome Iron Alloy.

Table II.—*Analysis of Metals Used for Corrosion Tests.*

Ferrous :—

Material.	T. C. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Ni. Per cent.	Cu. Per cent.	Cr. Per cent.
Ni-Resist	2.90	1.45	1.32	0.07	0.02	17.20	8.34	3.22
Ordinary cast iron ..	3.21	1.13	0.75	0.18	0.10	—	—	—
Mild steel	0.20	0.16	0.70	0.02	0.03	—	—	—
Stainless steel 18/8 ..	0.15	0.65	0.12	0.03	0.02	8.31	—	15.64

Non-ferrous :—

Material.	Cu. Per cent.	Sn. Per cent.	Zn. Per cent.	Pb. Per cent.	P. Per cent.	Fe. Per cent.	Ni. Per cent.	Mn. Per cent.
Bronze	84.96	9.14	2.26	3.64	Trace	Trace	—	—
Nickel bronze	61.63	7.56	7.64	3.17	—	1.00	18.90	0.10
Monel	29.08	—	—	—	—	3.25	66.23	1.43

* Produced by Henry Wiggin & Company, Limited.

A fully austenitic cast iron is generally soft and easily machined. Its susceptibility to surface-hardening by cold working, however, necessitates lower machining speeds than for ordinary cast iron, and tools should be kept sharp and in good condition. The best results are obtained using deep, heavy cuts rather than a light feed at high speeds. Castings which prove harder than desired may often be softened by heating to 850 to 950 deg. C. and cooling in air or by quenching in some mild medium if design permits. Rapid cooling of the castings after solidification also assists machinability, and it is a wise precaution to knock out as soon as possible and allow the casting to cool freely in air.

Austenitic cast iron may be readily welded by the arc or acetylene processes, using welding rods of similar material or alternatively of Monel metal. It is an advantage in the former instance to ensure the absence of chromium and to increase the nickel and silicon contents in the rods employed to counteract oxidation losses if welds of maximum machinability are required.

Application

Ni-Resist has very good resistance to attack by many corrosive agents, and this factor, coupled with adequate machinability, has led to its extended adoption in the chemical and allied industries for valves, pipes, pump and various machine parts. It has also proved successful for service in the paper, textile and food industries, as well as for general engineering requirements in the handling of sewage and industrial waters. Fig. 3 illustrates a few typical applications. The latest development is the use of austenitic cast iron for the production of automobile cylinder liners, as it has been proved that under certain conditions of engine operation corrosion plays an important part in cylinder wear.

Table III.—*Corrosion of Various Alloys by Acids, Set Out as Loss in Grms. per Sq. Metre per 24 Hours.*

Corroding media.	Ni-Resist.	Ordinary cast iron.	Mild steel.	Stainless steel 18/8.	Bronze.	Nickel bronze.	Monel.
Acetic acid, 5 per cent.	18.35	341.50	51.76	0.02	2.05	0.61	0.86
,, ,, 10 ,, ,,	10.72	441.50	61.34	0.01	1.96	0.67	0.65
,, ,, 25 ,, ,,	11.65	394.20	74.03	0.04	2.14	1.02	0.70
,, ,, 50 ,, ,,	39.85	320.60	76.50	no loss	4.28	1.12	0.82
,, ,, 75 ,, ,,	37.73	238.80	47.64	no loss	7.47	1.62	0.73
,, ,, concentrated	10.70	40.78	89.54	no loss	5.08	1.21	0.79
Carbolic acid, 5 per cent.	4.08	4.78	3.08	0.04	0.26	0.16	no loss
Citric acid, 5 per cent.	46.29	296.60	199.30	0.01	7.81	4.13	0.88
Hydrochloric acid, 5 per cent.	6.05	535.30	331.90	1.42	84.74	11.95	4.40
,, ,, 10 ,, ,,	4.66	611.50	787.40	3.40	95.30	8.74	4.38
,, ,, 25 ,, ,,	8.07	609.10	1,108.00	8.81	120.50	7.00	3.87
,, ,, 50 ,, ,,	23.03	618.60	1,482.00	28.34	101.10	58.33	23.04
,, ,, 75 ,, ,,	61.49	610.60	1,275.00	372.90	30.73	107.40	27.68
,, ,, concentrated	190.90	557.30	650.00	563.90	77.21	300.50	26.23
Nitric acid, 5 per cent.	425.70	515.80	704.90	0.05	103.30	13.77	9.59
,, ,, 10 ,, ,,	1,217.00	1,515.00	1,303.00	no loss	247.30	74.74	60.42
,, ,, 25 ,, ,,	528.80	572.50	3,306.00	no loss	2,303.00	737.40	675.70
,, ,, 50 ,, ,,	531.60	379.80	total loss	no loss	total loss	880.20	6,679.00
,, ,, 75 ,, ,,	451.50	347.40	20.26	no loss	total loss	total loss	total loss
,, ,, concentrated	383.60	338.10	12.36	0.03	total loss	total loss	total loss
Sulphurous acid(6 per cent.SO_2)	131.80	557.20	511.10	no loss	0.07	0.02	0.05
Sulphuric acid, 5 per cent.	3.04	614.50	917.00	0.02	14.40	4.89	2.77
,, ,, 10 ,, ,,	2.26	702.00	1,474.00	0.60	5.00	1.97	1.52
,, ,, 25 ,, ,,	0.53	675.60	1,179.00	42.01	3.26	0.95	0.32
,, ,, 50 ,, ,,	0.76	5.28	7.39	103.80	0.13	0.49	0.25
,, ,, 75 ,, ,,	3.05	2.33	3.12	5.52	0.58	5.72	4.53
,, ,, concentrated	1.92	1.11	1.27	0.17	9.56	8.21	2.35

Table IV.—*Corrosion of Various Alloys by Alkalis, Set Out as Loss in Grms. per Sq. Metre per 24 Hours.*

Corroding media.	Ni-Resist.	Ordinary cast iron.	Mild steel.	Stainless steel 18/8.	Bronze.	Nickel bronze.	Monel.
Ammonia, 5 per cent.	0.01	no loss	0.03	no loss	12.61	3.68	0.10
,, 10 ,, ,,	0.11	no loss	no loss	no loss	39.43	7.37	0.05
,, 25 ,, ,,	0.09	no loss	0.02	no loss	219.90	183.10	0.29
,, 50 ,, ,,	no loss	no loss	0.05	0.01	333.71	265.60	0.41
,, 75 ,, ,,	no loss	no loss	no loss	no loss	112.00	5.10	3.00
,, concentrated	no loss	1.11	no loss	0.04	95.19	2.38	1.30
Caustic soda, 5 per cent.	no loss	0.08	0.06	0.01	4.32	0.39	0.08
,, ,, 10 ,, ,,	0.02	0.62	0.10	0.02	2.77	0.39	0.17
,, ,, 25 ,, ,,	0.01	0.15	0.23	0.01	1.19	0.26	0.14

Attention should also be drawn to the fact that, due to its work-hardening properties, this material is of service in those applications where abrasive wear is present as well as corrosive influences, such as, for example, in equipment handling liquids containing suspended solids, etc.

As further experience is gained relative to the effect of the variety of industrial conditions encountered, it can be anticipated that the use of alloys in this group will be considerably extended. Tables II to VI may be of assistance in indicating the resistance of austenitic cast iron to the attack of various media. These data give the results of actual tests conducted under the direction of the author in aerated solutions at 60 deg. F. (unless otherwise stated), and the comparison of Ni-Resist with ordinary cast iron, mild and stainless steel, together with typical non-ferrous alloys should be of value. A simple assessment of the order of resistance can readily be made by comparison of the test results obtained from a liquid having known effect (such as one or other of the industrial waters) against any other particular media under consideration.

These results are still more illuminating if plotted graphically as shown in Fig. 4, which indicates the behaviour of ordinary grey iron, Ni-Resist, and iron containing 30 per cent. chromium, when subjected to the attack of four common acids—sulphuric, hydrochloric, nitric and acetic—at various concentrations. It will be observed that the austenitic iron is very resistant to the attack of sulphuric acid in concentrations up to 50 per cent., but shows little advantage over ordinary grey iron at higher concentrations. On the other hand it is quite unsatisfactory for handling nitric acid where the high-chromium iron shows up to greatest advantage.

Many engineering structures in ordinary iron or steel are rapidly deteriorated even when operating under mildly corrosive agents such as river or sea water. Accelerated attack can be brought about by several causes—for instance, electrolytic action due to contact with a dissimilar metal such as bronze, or through turbulence and variation in oxygen content of the liquid itself. The use of austenitic cast iron is of considerable assistance in overcoming troubles of this nature, and it might also be noted that this material does not appear to be subject to the defect of "graphitic softening" not infrequently associated with ordinary iron castings.

Table V.—*Corrosion of Various Alloys by Miscellaneous Solutions, Set Out as Loss in Grms. per Sq. Metre per 24 Hours.*

Corroding media.	Ni-Resist.	Ordinary cast iron.	Mild steel.	Stainless steel 18/8.	Bronze.	Nickel bronze.	Monel.
Ammonium chloride, 5 p. cent.	1.53	23.33	11.39	0.03	10.26	5.38	1.03
,, ,, at 200° F.	2.83	97.23	55.39	1.19	15.41	11.66	6.96
,, ,, 10 p. cent.	3.85	21.14	10.90	no loss	7.42	5.06	6.25
,, ,, at 200° F.	2.83	104.60	49.74	1.12	11.34	8.39	6.82
,, ,, 20 p. cent.	5.27	23.28	8.33	no loss	5.04	3.70	8.24
,, ,, at 200° F.	3.16	115.20	39.57	0.76	7.16	5.38	3.98
Ammonium sulphate, 5 p. cent.	3.05	13.85	4.92	0.02	4.53	2.42	0.26
,, ,, 10 ,,	2.16	15.13	4.99	0.03	9.81	3.38	0.16
,, ,, 25 ,,	0.37	5.74	1.65	0.01	6.76	1.56	1.41
Aluminium sulphate, 5 p. cent.	8.17	17.35	72.23	no loss	0.15	1.77	4.57
Benzine	no loss	no loss	0.04	no loss	0.06	0.05	no loss
Copper sulphate, 0.5 per cent.	21.25	55.51	32.28	no loss	0.51	0.65	1.15
,, ,, 10 ,, ,,	255.70	556.00	496.70	no loss	3.45	3.55	2.59
Calcium chloride, 5 per cent.	2.75	4.77	3.54	0.01	1.25	0.86	0.25
Calcium hypochlorite, conc. ..	0.39	3.12	4.30	no loss	0.98	0.32	no loss
Calcium and magnesium chlorides (5 per cent. each) ..	2.31	2.44	2.57	0.02	1.06	1.03	0.13
Lime water	0.11	1.52	0.99	no loss	0.31	0.05	0.01
Milk of lime	no loss	0.71	0.38	no loss	0.51	0.14	0.06
Magnesium chloride, 5 per cent.	3.37	5.31	3.26	0.01	0.92	0.59	0.46
Petrol	0.25	0.26	0.42	0.04	0.24	0.03	0.30
Potash alum, 0.5 per cent. ..	1.09	3.17	2.95	0.02	0.42	0.56	2.33
10 ,, ,, ..	5.27	15.72	14.35	0.04	2.30	2.83	5.41
Soda ash, 5 per cent.	no loss	no loss	no loss	no loss	0.69	0.08	0.03
,, ,, 10 ,, ,, ..	no loss	no loss	0.02	no loss	0.32	0.83	0.10
Sodium chloride, 5 per cent. ..	2.94	3.01	2.90	0.02	1.71	0.62	0.10
,, ,, at 200° F. ..	1.43	2.27	2.57	no loss	2.69	0.10	0.16
,, ,, 10 per cent. ..	1.93	2.98	2.36	0.01	2.33	0.75	0.43
,, ,, at 200° F. ..	0.99	2.04	3.25	0.25	2.89	1.13	1.06
,, ,, 20 per cent. ..	1.76	1.74	1.69	0.01	1.41	0.66	0.37
,, ,, at 200° F. ..	0.64	1.01	1.67	0.28	1.97	0.74	0.79
Sodium aluminate, 5 per cent.	no loss	no loss	0.05	no loss	1.08	no loss	no loss
,, ,, 10 ,, ..	no loss	no loss	0.01	no loss	1.07	0.79	0.31
Sodium phosphate, 5 per cent.	0.03	0.20	0.09	no loss	0.14	0.05	0.02

HIGH-CHROMIUM CAST IRON

This is the most recent addition to the range of corrosion-resisting alloys to receive the attention of ironfounders, although with low carbon content it has been familiar to the steelfounder since about 1914. Its introduction has been brought about in the main through the development of low-carbon ferro-chromium by

Becket, which material is more or less essential to the production of commercial high-chromium castings. In view of the high cost of raw materials, castings in this alloy are somewhat more expensive to produce than the corrosion-resisting irons previously outlined.

Composition and Physical Properties

The most suitable range of alloys for production in the iron foundry are those having a composition within the following limits:—Total carbon, 1.0 to 2.0 per cent.; silicon, 0.8 to 1.2 per cent.; manganese, 0.5 to 1.0 per cent.; sulphur, 0.05 per cent. max.; phosphorus, 0.10 per cent. max.; and chromium, 25.0 to 30.0 per cent.

From experiments conducted by the author, it was found that if a reasonable measure of machinability is to be obtained in the cast state, it is important to limit the carbon content between 1.0 and 1.5 per cent. Between 1.5 and 2.0 per cent. an annealing treatment is desirable, but when the carbon exceeds 2.0 per cent. machinability is difficult to assure even after long annealing periods. This is due to the formation of exceedingly hard and stable carbides which are not readily broken down by heat-treatment. Accordingly, the main point of primary importance in the founding of high-chromium cast iron is to ensure accurate control of the carbon content between the limits given. This is not an easy matter as it entails the use of ferro-chromium, containing certainly not over 0.2 per cent. carbon, together with high percentages of mild steel scrap as a basis for the furnace charge. Furthermore, melting must not be conducted in the presence of carbon or in an atmosphere containing carbon-monoxide (CO), as otherwise excessive carbon pick-up will occur. For this reason cupola melting is entirely impracticable.

The presence of nitrogen in the alloy has been found to assist materially the production of close-grained castings and improves the strength and toughness without affecting hardness or machinability. This element can be conveniently added by using high-nitrogen ferro-chrome.

High-chromium cast iron has the following physical properties:—Density, 7.42 to 7.43; tensile strength, 31.0 to 37.0 tons per sq. in.; elongation, nil to 0.5 per cent.; Brinell hardness, 250 to 350; melting point, 1,400 to 1,410 deg. C.; and contraction, 0.25 in. per ft.

Table VI.—*Corrosion of Various Alloys by Industrial Waters, Set Out as Loss in Grms. per Sq. Metre per 24 Hours.*

Corroding media.	Ni-Resist.	Ordinary cast iron.	Mild steel.	Stainless steel 18/8.	Bronze.	Nickel bronze.	Monel.
Distilled water	0.33	5.51	6.15	no loss	0.16	0.14	0.07
Domestic water from chalk-free areas	1.17	7.48	10.49	no loss	0.14	0.12	0.09
As above at 200° F.	0.57	3.35	3.65	0.03	0.28	0.11	0.02
Domestic water saturated with carbon dioxide (CO_2)	0.88	13.67	4.18	0.04	0.07	0.02	0.05
Domestic water plus 0.1 per cent. aluminium sulphate	0.90	2.29	2.37	no loss	0.54	0.82	1.10
Domestic water plus 0.1 per cent. copper sulphate	18.04	13.05	15.93	no loss	0.34	0.17	0.57
Domestic water plus 0.07 per cent. calcium hypochlorite	1.09	3.97	5.29	no loss	0.19	0.17	0.03
Domestic water plus 0.1 per cent. potash alum	0.66	2.14	2.48	0.03	0.87	1.02	0.94
Domestic water plus 0.1 per cent. sodium phosphate	0.10	0.17	0.61	0.02	0.05	no loss	no loss
Domestic water plus 0.07 per cent. soda ash	0.78	3.81	3.18	0.01	0.05	0.03	no loss
As above at 200° F.	0.59	1.51	2.10	0.04	0.37	0.17	0.32
Domestic water plus 0.07 per cent. sodium aluminate	0.12	1.67	1.07	0.02	0.15	0.03	0.02
As above at 200° F.	0.80	2.03	2.12	0.02	0.84	0.03	no loss
River water	1.29	5.50	3.93	0.01	0.11	0.11	0.05
River water at 200° F.	0.92	3.29	3.14	0.01	0.11	0.09	0.09
Sea water	2.46	3.50	4.14	no loss	1.23	0.52	0.31
Sea water at 200° F.	0.12	1.79	2.15	0.02	0.75	0.18	0.34

Table VII.—*Influence of Melting Time on the Carbon Pick-up of High-Chromium Alloys.*

	Calculated analysis.	Actual analysis obtained.	
		Melting time 3 hrs.	Melting time 5 hrs.
Total carbon, per cent.	0.60	1.43	2.06
Silicon ,,	0.70	0.94	0.89
Manganese ,,	0.43	0.25	0.37
Phosphorus ,,	—	0.096	0.028
Sulphur ,,	—	0.034	0.016
Chromium ,,	28.00	30.59	26.97

Production Methods

Alloys in this group can only be melted in crucible, reverberatory or electric furnaces, and it is a very great advantage to have an oxidising atmosphere present. Successful castings have been produced by the author using a forced-draft coke-fired crucible furnace from the following metal mixture:—91 lbs. ferro-chrome (0.18 per cent. C, 66.0 per cent. Cr); 97 lbs. mild steel scrap ($\frac{1}{2}$ in. plate shearings), and 26 lbs. cast-iron scrap (3.4 per cent. C, 1.9 per cent. Si, 0.3 per cent. P).

The ferro-chrome and steel scrap were charged first with the cast-iron scrap placed on top. During melting a flux composed of equal parts of iron oxide (Fe_2O_3) and cupola slag was used to promote oxidising conditions and to prevent carbon absorption as far as possible. As an extra precaution the top of the crucible was covered with the bottom of an old crucible to prevent the entry of coke and all possible steps taken to ensure as rapid melting as possible. Before pouring the metal was deoxidised with a little ferro-manganese and ferro-silicon.

The calculated carbon content of the above mixture was 0.60 per cent. and even with the precautions taken the resultant castings showed 1.43 per cent. carbon after a melting time of 3 hours. Under similar conditions a previous melt over 5 hours analysed 2.06 per cent. carbon. The complete analyses obtained are shown in Table VII, which indicates the great affinity of the material for carbon and the need for allowing for a large carbon pick-up.

Steel-moulding practice was adopted for the manufacture of moulds which were made in dry sand using a refractory wash made from 40 parts finely ground sillimanite, 2 parts bentonite and 70 parts water. With mould washes containing carbon, such as plumbago or blacking, difficulties are likely to be experienced from a hard skin on the castings due to carbon absorption.

The most suitable procedure for the annealing of the castings is to reheat to 850 deg. C. and hold at this temperature for about 1 hour and cool as slowly as possible down to 600 deg. C., then more rapidly if desired. The time taken to cool from 850 to 600 deg. C. should cover a period of at least 6 hours. Even if the castings have good machinability a short anneal is recommended to relieve casting strains.

Applications

High-chromium cast iron has a particularly good resistance to the corrosive effect of many industrial waters and under such conditions is more or less rustless. Fig. 5 illustrates roller sections made in ordinary grey iron and 30 per cent. chrome material after 2 years' immersion in tap water. The latter material is still as bright and free from corrosion as the day it was machined. Fig. 6 shows a plug cock and valve face made from the alloy, and results of corrosion tests are tabulated, for comparison with the previous irons discussed, in Table VIII. The

(*Concluded on page 282.*)

Table VIII.—*Corrosion of Chromium Cast Iron containing Total Carbon 1.43, Silicon 0.94, and Chromium 30.59 per cent. by Various Media.*

Corroding media.	Loss in grms. per sq. metre per 24 hours.	Corroding media.	Loss in grms. per sq. metre. per 24 hours.
Acetic acid, 5 per cent.	0.04	Ammonium sulphate, 5 per cent.	0.03
,, ,, 10 ,,	0.46	,, ,, 25 ,,	0.03
,, ,, 25 ,,	0.02	Aluminium sulphate, 5 per cent.	No loss
,, ,, 50 ,,	0.04	Copper sulphate, 0.5 per cent.	,,
,, ,, 75 ,,	0.02	,, ,, 10 ,,	,,
,, ,, concentrated	No loss	Calcium chloride, 5 per cent.	0.66
Carbolic acid, 5 per cent.	0.05	,, hypochlorite, concentrated	No loss
Citric acid, 5 per cent.	0.03	,, and magnesium chlorides (5 per cent. each)	1.06
Hydrochloric acid, 5 per cent.	127.30	Lime water	No loss
,, ,, 75 ,,	638.70	Milk of lime	,,
Nitric acid, 5 per cent.	0.06	Magnesium chloride, 5 per cent.	0.61
,, ,, 10 ,,	0.03	Potash alum, 0.5 per cent.	0.02
,, ,, 25 ,,	0.01	,, ,, 10 ,,	0.12
,, ,, 50 ,,	0.03	Sodium chloride, 5 per cent.	1.06
,, ,, 75 ,,	0.08	,, ,, at 200 deg. F.	0.62
,, ,, concentrated	0.05	Distilled water	No loss
Sulphurous acid (6 per cent. SO_2)	0.05	Domestic water from chalk-free areas	,,
Sulphuric acid, 5 per cent.	358.20	Domestic water saturated with carbon dioxide (CO_2)	0.04
,, ,, 10 ,,	707.30	Domestic water plus 0.1 per cent. copper sulphate	No loss
,, ,, 25 ,,	525.30	Domestic water plus 0.07 per cent. calcium hypochlorite	,,
,, ,, 50 ,,	66.28	River water	0.01
,, ,, 75 ,,	2.50	Sea water	1.90
,, ,, concentrated	0.34	,, at 200 deg. F.	0.22
Ammonia, 5 per cent.	No loss		
,, concentrated	0.03		
Caustic soda, 5 per cent.	0.02		
,, ,, 25 ,,	No loss		
Ammonium chloride, 5 per cent.	0.22		
,, ,, at 200 deg. F.	2.40		
,, ,, 20 per cent.	0.97		
,, ,, at 200 deg. F.	2.25		

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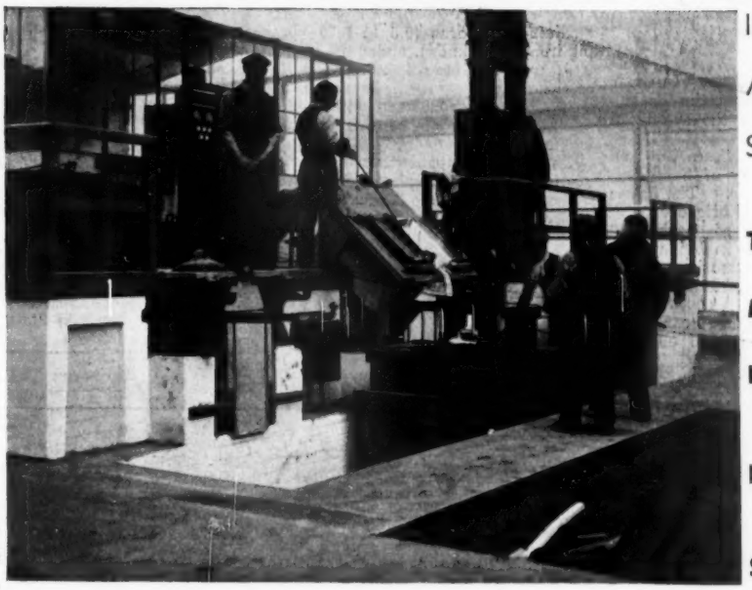

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The Week's News in Brief

Trade Talk

THE STEEL COMPANY OF SCOTLAND, LIMITED, Glasgow, have received an order from the Bengal-Nagpur Railway Administration for the supply of 1,000 carriage and wagon tyres.

AN OUTBREAK of fire, involving a Nissen hut and its contents, occurred at the foundry of Sanderson & Robinson, Limited, Mansfield, Notts. The flames were quickly estinguished by the fire brigade.

SIR CORNELIUS CHAMBERS, head of Gaskell & Chambers, Limited, of Birmingham, on Friday last laid the foundation stone of an extension of the Dale End factory. The extension includes a non-ferrous metal foundry.

THE LONDON PASSENGER TRANSPORT BOARD has this week placed an order for reinforced concrete segments for 2½ miles of tube-railway tunnel. Hitherto cast iron has been used exclusively for this purpose. A thicker section is to be used.

A 300-TON TILTING FURNACE at the works of Appleby-Frodingham Steel Company, Limited, Scunthorpe, has created what is believed to be a record for Great Britain for the output of one steel furnace in one week. This furnace produced 2,800 tons of steel ingots last week.

A VISIT by members of the Institute of Vitreous Enamellers to the works of The General Electric Company, Limited, at Landor Street, Birmingham, has been arranged for April 5. Members participating will meet at the main entrance of the works at 2.30 p.m.

THE INTERNATIONAL LAUNDRY AND ALLIED TRADES EXHIBITION, organised by F. W. Bridges & Sons, Limited, was opened last Monday at the Agricultural Hall, London, by Sir Duncan Wilson, H.M. Chief Inspector of Factories. A number of large foundries are exhibiting

FOLLOWING the annual meeting of the London Branch of the Institute of British Foundrymen, to be held on April 6 at the Charing Cross Hotel, London, Mr. G. E. France (managing director of Augusts, Limited) will give an address on "Some Aspects of Foundry Mechanisation."

FORTY-FOUR NEW FURNACES have been put in circuit by the British Aluminium Company, Limited, at Lochaber. This is about one-third of the total number of new furnaces to be started up when the factory extension is completed. The building of the workmen's new hostel, which will accommodate 250 workmen, has also been commenced.

THE STANTON IRONWORKS COMPANY, LIMITED, near Nottingham, announce the introduction of a new medium-phosphorus (0.5 to 0.75 per cent.) foundry pig-iron, to be known under the name of "Glenton." This iron has been introduced with the object of catering for the recent extension in demand from those foundries concerned with engineering castings, when the primary consideration is strength at medium cost.

THE FIFTH ANNUAL GENERAL MEETING of the Combustion Appliance Makers' Association (Solid Fuel) was held at the Dorchester Hotel, London, yesterday. In the course of his address the President, Mr. J. Arthur Reavell, drew attention to the rapid growth of the Association during the five years of its existence as revealed by the facts and figures recorded in the fifth annual report of the General Council.

GENERAL REFRACTORIES, LIMITED, have circularised their shareholders to the effect that as the size of the company's business and that of the group of which it is the head has grown so much since the last annual general meeting (March 31, 1937), and as the directors have decided to publish, along with the accounts of the company, a consolidated balance-sheet showing the position of the parent company and the whole of the subsidiaries it controls, so much more time is necessary that it is impossible to hold the meeting as early as usual this year. The consolidated balance-sheet is being prepared jointly by Messrs. Holmes Widlake & Gibson, and Peat, Marwick, Mitchell & Company, and the last-named are collaborating with the whole of the auditors in the group in the preparation and certification of the individual accounts of the subsidiary companies as at December 31 last, from which the consolidated balance-sheet is being prepared. This task is being performed as expeditiously as possible, with a view to the meeting being held about the end of April or the beginning of May.

Corrosion-Resisting Cast Iron—Its Production and Use

(*Concluded from page* 280.)

material does not score or seize readily and wears well due to the presence of a small amount of graphite. It resists abrasion under corrosive conditions and compressive stresses to a high degree.

Alloys in this group have excellent resistance to the attack of nitric acid but fail in the presence of sulphuric and hydrochloric acids. From the corrosion tests conducted it would appear that their use might also be considered for service with sulphurous, acetic, citric and carbolic acids as well as for several other chemical solutions.

In conclusion it cannot be too strongly emphasised that one must never expect to find a single alloy which is universally resistant to every service condition. All of the corrosion-resisting cast irons discussed in this Paper have their individual advantages for some special application, and it is hoped that this brief review may assist both the foundryman and the engineer in selecting material to meet respective requirements.

BIBLIOGRAPHY

7 British Patent 2296/1799.
8 Russell, P. A.: "Some Experiments with Austenitic Cast Irons." FOUNDRY TRADE JOURNAL, Oct. 31, 1935, pp. 325-327.
9 Russell, P. A.: "Experiments in the Manufacture of High-Grade Alloy Cast Iron." Proc. I.B.F., 1934-35, vol. 28, pp. 482-504.

Personal

MR. A. L. HARVEY has been appointed assistant engineer to Mr. R. F. Hindmarsh, chief engineer to the Tyne Improvement Commission.

CONGRATULATIONS are due to Mr. Joseph A. D. Baker, of J. A. D. Baker & Sons Limited, iron-founders, of Priory Street, Bedford, and Mrs. Baker, who have recently celebrated their diamond wedding.

MR. E. H. WOOTTON, manager of the Dick, Kerr works of the English Electric Company, Limited, has resigned in order to join the staff of Urwick, Orr & Partners, Limited, consultants in organisation and management.

MR. F. LONSDALE and MR. E. A. PITCHER have been appointed joint managers of Fraser & Chalmers Engineering Works, Erith. Mr. Lonsdale joined Fraser & Chalmers, Limited, in 1909, and after spending some time in the turbine section, was appointed chief draughtsman and subsequently made manager of the turbine contracts department and drawing office. When the firm was absorbed by the G.E.C. in 1918, he became sales manager, a position in which he has become known to a very wide circle in the engineering profession. Mr. E. A. Pitcher joined Fraser & Chalmers, Limited, in 1893 and, after some years in the London office, became, in 1914, when the executive offices were transferred to the works, assistant manager at Erith. At the changeover in 1918 he was appointed commercial manager. Mr. Pitcher has a specially wide knowledge of the mining industry.

Obituary

MR. WILLIAM JACK, a director of the Forth & Clyde Steel Foundry (1932), Limited, Kirkintilloch, died recently.

MR. ALLAN CARR, works manager of Ideal Boilers & Radiators, Limited, Hull, died suddenly on Friday, March 18, aged 64.

MR. THOMAS WHITEHEAD HAWKINS, formerly manager of J. & W. McNaught, engineers, of Rochdale, now known as Petrie & McNaught, Limited, from which he retired 20 years ago to join the firm of Hughes & Lancaster, Limited, at Ruabon, North Wales, has died, aged 78.

Contracts Open

Ampthill, April 11.—Provision and laying of 249 yds. of 3-in. cast-iron pipes, for the Urban District Council. The Surveyor, The Council Chamber, Ampthill. (Fee £1 1s., returnable.)

Blackpool, April 12.—Cast-iron specials, for the Fylde Water Board. Mr. G. F. Atkinson, engineer, Sefton Street, Blackpool.

Lexden and Winstree, April 16.—Supply and laying of 3,760 yds. of 3-in. spun cast-iron water mains, for the Rural District Council. Sands & Walker, consulting engineers, Milton Chambers, Nottingham. (Fee £2 2s., returnable.)

Melford, April 13.—93 tons of 3-in. and 4-in. dia. spun cast-iron pipes (class C), with 5 tons of special pipe castings, for the Rural District Council. Sands & Walker, consulting engineers, Milton Chambers, Nottingham. (Fee £3 3s., returnable.)

Saffron Walden, April 11.—Provision and laying of cast-iron water mains and castings, for the Rural District Council. Sands & Walker, consulting engineers, Milton Chambers, Nottingham. (Fee £3 3s., returnable.)

Weddicar, April 16.—Providing and laying 650 yds. of 4-in. dia. spun-iron pipes, for the Ennerdale Rural District Council. Mr. R. Brown, engineer, Council Chambers, Cleator, Cumberland.

Littleborough, April 9.—Supply and erection of four sets of electrically-driven, vertical unchokeable centrifugal sewage pumps, for the Urban District Council. J. Taylor & Sons, engineers, Caxton House, Westminster, S.W.1. (Fee £2, returnable.)

Company Reports

Blythe Colour Works, Limited.—Net profit for 1937, £34,218; brought in, £4,474; dividend of 17½ per cent. on the ordinary shares; carried forward, £7,541.

Radiation, Limited.—Profit for 1937, £327,682; brought in, £127,483; to general reserve, £20,000; final dividend of 9⅜ per cent., making 12½ per cent., and a bonus of 2½ per cent.; carried forward, £131,688.

Gibbons (Dudley), Limited.—Net profit for 1937, after providing for income tax, N.D.C., and depreciation, £18,832; brought in, £12,349; 7 per cent. preference dividend, free of tax, £2,100; dividend of 10 per cent. on the ordinary shares, £10,031; part of cost of modernising works, written off, £4,000; to dividend equalisation fund, £2,500; carried forward, £12,100.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

John France & Company (Iron & Steel), Limited, 8, George Street, Heckmondwike, Yorks.—Capital, £12,500 in £1 shares. Iron and steel merchants. Directors: H. Coulter, J. W. Midwood and M. Crawshaw.

Kenneth Hill & Company, Limited.—Capital, £3,000. Manufacturers of metallic abrasives, foundry machinery, etc. Directors: K. Hill, 42, Napier Court, Hurlingham, London, S.W.6, and H. T. O. Culliford.

Forthcoming Events

APRIL 6.

Institution of Mechanical Engineers (North-Eastern Branch):—"Heavy Forgings." Paper by H. H. Burton, at Technical College, Darlington, at 6.30 p.m.

APRIL 7.

Institute of Welding (Leeds and District Branch):—Annual dinner, at Griffin Hotel, Leeds, at 7.15 p.m.

APRIL 8.

Institution of Mechanical Engineers:—"Report on Carbide Tools," by Prof. Dempster Smith, at Storey's Gate, St. James's Park, London, at 6 p.m.

Institute of British Foundrymen

APRIL 4.

Lincolnshire Section:—Annual general meeting and short Papers, at Lincoln Technical College, at 6.45 p.m.

APRIL 6.

London Branch:—Annual general meeting; "Some Notes on Mechanisation," Paper by G. E. France, at Charing Cross Hotel, London, at 8 p.m.

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MIDDLESBROUGH OFFICE : Halifax Bldgs., Exchange Place, Telephone : Middlesbrough 3313. Telegrams : "Genefax, Middlesbrough." (Mr. J. A. Williams).

CARDIFF OFFICE : 17, Windsor Place, Telephone : 5796. Telegrams : "Genefax, Cardiff." (Mr. F. E. Rutter).

Raw Material Markets

An early announcement is expected to be made by the Import Duties Advisory Committee to the effect that the duty on pig-iron imported into this country will be reimposed. Such a move should result in an expansion in the demand for home-produced iron. Orders for steel are also likely to increase after the end of the current month, when the duties on imported material will return to the levels in operation during the first six months of last year.

Pig-Iron

MIDDLESBROUGH.—While the demand for pig-iron has been unsatisfactory so far this year, producers have made little contraction in their outputs, and, consequently, supplies should be plentiful when consumers re-enter the market. The effect of the expected reimposition of the import duty may not be immediately felt, as consumers, in many cases, have in recent months accumulated substantial tonnages of iron at their plants. For delivery in Middlesbrough or Falkirk up to the end of June, No. 3 Cleveland G.M.B. iron is quoted at 109s. per ton, with No. 1 foundry at 111s. 6d. and No. 4 foundry and No. 4 forge at 108s., all less 5s. rebate.

The hematite market remains quiet. Satisfaction is felt at the conclusion of the Anglo-Italian trade agreement, as it is expected that this will open the way for a considerable amount of business in hematite with Italian consumers. It is hoped that difficulties with regard to payments will be overcome. Hematite mixed numbers are quoted at 132s. 6d. for delivery on the North-East Coast, 138s. in Sheffield, and 143s. 6d. in Birmingham, all less 5s. per ton rebate.

LANCASHIRE.—Business in foundry iron is slow to develop and only small tonnages are changing hands. Light-castings founders and textile-machinery makers have still unsatisfactory order-books and the outlook does not appear to be too promising. For delivery to users in the Lancashire price zone, Staffordshire and Derbyshire brands of No. 3 foundry iron are quoted on the basis of 114s., with Northants at 112s. 6d. and Derbyshire forge iron at 111s. to 113s., according to the class of user. West Coast hematite is on offer on the basis of 141s. and East Coast material at around 140s. 6d., both delivered equal to Manchester. Supplies of hematite are more than sufficient to meet current requirements.

MIDLANDS.—The foundry iron market in this area continues to be dull and very little new business is being arranged. Several of the light-castings foundries are having to work short time. For delivery to Birmingham and Black Country stations, Northamptonshire No. 3 is quoted at 108s. 6d., with Derbyshire at 111s., less 5s. rebate. Low-phosphorus iron is being taken up in fairly good tonnages at prices ranging from £6 2s. 6d. to £7 3s. 6d. per ton. Steady deliveries of hematite are being made, but little in the way of new business is being negotiated. East Coast No. 3 is quoted at £7 3s. 6d., with West Coast mixed numbers at £7 4s. 6d. Refined iron at £8 5s. is quiet.

SCOTLAND.—Consumers are still taking up heavy tonnages of foreign pig-iron. In many cases they are already well stocked and it will be a considerable time before the need arises to buy home-produced iron. No. 1 foundry is quoted at 120s. 6d. and No. 3 at 118s., f.o.t. furnaces. Basic iron is still arriving in good tonnages from abroad. Hematite mixed numbers are quoted at 133s., Scottish basic at 107s. 6d., and English and Indian basic at 100s., all less 5s. rebate, and delivered f.o.t. local steelworks.

Coke

There continues to be little activity in the foundry-coke market, consumers hoping that lower prices will obtain during the summer, despite statements to the contrary from the producers. For delivery in Birmingham and district, best Durham coke is quoted at 55s. 9d. and Welsh coke at from 55s. to 62s. 6d. per ton, according to quality.

Steel

The brighter conditions noticeable recently in the steel market remain in evidence, and, while new business is still restricted, trading has shown a tendency to broaden. This is in a measure due to a seasonal increase in the demand, partly to the restoration of the import duties at the end of the month, and also to expectations that the speeding up of the rearmament programme may lengthen delivery dates. The improvement, however, has not yet spread to all departments of the market, and quiet conditions rule in those sections in which recent supplies of imported steel have been on a heavy scale. Business in the semi-finished steel department of the market has been inactive. Considerable imports of foreign material have recently arrived in this country, and trading is likely to remain quiet until these have been absorbed. In the finished steel section, busy conditions rule at the heavy steel works, but in some of the lighter departments conditions are less active than a few weeks ago. The demand for structural steel remains at a high level. Export business is quiet, although inquiry from overseas markets has an improving tendency.

Scrap

The iron and steel scrap trade is now quieter than it has been for a long time past. The demand for all qualities has fallen away compared with what it was a few months ago, and there appear to be no indications of any early improvement. Although supplies are plentiful, cargoes of scrap are still arriving from abroad.

Metals

Despite the obvious needs of the rearmament programme, there has been little expansion in the demand for non-ferrous metals during the past week. No doubt larger tonnages will be taken up when political conditions are more stable.

Copper.—Only a quiet demand on industrial account continues to circulate. Speculative interest, which was shown quite strongly at times, now appears to have vanished. The tone of the market in this country is still damped down by the dullness of the American situation, while the Continental position is not helped by the metallurgical workers' strikes in France. A feature of the copper market is the continued buying by the Soviet Union and the manner in which that country is increasing both her home production and her imports of copper, presumably to keep pace with her armament programme and her rapid industrial developments.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £39 6s. 3d. to £39 8s. 9d.; Friday, £39 10s. to £39 12s. 6d.; Monday, £38 12s. 6d. to £38 13s. 9d.; Tuesday, £39 to £39 1s. 3d.; Wednesday, £38 1s. 3d. to £38 2s. 6d.

Three Months.—Thursday, £39 11s. 3d. to £39 13s. 9d.; Friday, £39 16s. 3d. to £39 17s. 6d.; Monday, £38 17s. 6d. to £38 18s. 9d.; Tuesday, £39 3s. 9d. to £39 5s.; Wednesday, £38 6s. 3d. to £38 7s. 6d.

Tin.—The March issue of the Statistical Bulletin of the International Tin Research and Development Council, published by The Hague Statistical Office, states that world tin production in January, 1938, amounted to 13,600 tons, an increase of 800 tons as compared with January, 1937. The exports from the signatory countries in January fell short of the quotas by 756 tons, bringing the total under-export to a figure of 2,158 tons. World apparent tin consumption in January amounted to 13,800 tons, against 16,800 tons in the preceding month and 16,200 tons in January, 1937. World tinplate production in January amounted to 214,000 tons, against 255,000 tons in December and 323,000 tons in January, 1937. The use of tin in this industry dropped from 4,100 tons in December to 3,400 tons in January. During February, 1938, visible stocks decreased by 1,659 tons to 23,308 tons, representing 12 per cent. of the current annual rate of consumption.

As suggested in these columns last week, the meeting of the International Tin Committee which was to have been held in Paris on April 5 has been postponed. No date has yet been fixed for the next meeting. The reason for postponing the meeting was that the results of the Malayan referendum would not be available by April 5.

At a meeting of the local advisory committee of the Tin Producers' Association, held in Kuala Lumpur recently, a resolution was passed without dissent which stated that the committee reaffirmed their entire approval in principle of a buffer stock scheme as an essential adjunct for the stabilisation of prices in the interests of consumers' and producers, and urged the Government, if not satisfied that a substantial majority of producers favoured such a scheme, to hold a referendum on a tonnage basis without delay.

No statement was issued after the meeting of the Council of the F.M.S. Chamber of Mines recently, but it is known that the buffer pool proposals were debated at length. It is understood that opinion was about equally divided.

The Malayan Government was advised to give careful consideration to the desirability of tendering notice of withdrawal from the international tin control agreement by Sir John Bagnall, the chairman of the Straits Trading Company, in his annual speech to shareholders on Monday. Sir John also advised the Malayan Government to make a formal application to the International Tin Committee for the acceptance by the signatory Governments of the 1937 tonnages for the remainder of the current agreement in place of the present standard tonnages, which, he said, had been shown to be seriously inequitable.

It is understood that representatives of the Cornish tin-mining industry will see Sir Thomas Inskip on Tuesday of next week. Proposals will then be discussed for subsidising the industry in some way in order that its output could be expanded rapidly in the event of war. The industry is hopeful that a scheme will be approved.

Official quotations were as follow :—

Cash.—Thursday, £183 10s. to £184; Friday, £184 7s. 6d. to £184 12s. 6d.; Monday, £183 to £183 2s. 6d.; Tuesday, £182 10s. to £182 12s. 6d.; Wednesday, £173 to £173 10s.

Three Months.—Thursday, £184 to £184 5s.; Friday, £184 15s. to £185; Monday, £183 5s. to £183 10s.; Tuesday, £183 to £183 5s.; Wednesday, £173 5s. to £173 10s.

Spelter.—The general demand remains at a low level and consumers who might be expected to be taking up good tonnages now are comparatively quietly employed. The world's smelter output of spelter in January totalled 142,859 metric tons, against 145,499 tons in December, according to the Metallgesellschaft.

Daily market prices :—

Ordinary.—Thursday, £14 6s. 3d.; Friday, £14 6s. 3d.; Monday, £14 2s. 6d.; Tuesday, £14 3s. 9d.; Wednesday, £13 16s. 3d.

Lead.—This market has been quite firm, and quite a good tonnage has changed hands. Fears that supplies of Mexican lead may be impeded by the labour troubles have been substantiated by reports from that area.

An admission that the position of the building industry is not so well maintained as at this time in recent years is made in the current issue of "The Building Industries Survey," published by the Building Industries National Council. The number of building operatives unemployed in February was some 12 per cent. greater than a year ago.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £16 1s. 3d.; Friday, £16 5s.; Monday, £16 6s. 3d.; Tuesday, £16 6s. 3d.; Wednesday, £15 18s. 9d.

Scrap.—Demand for non-ferrous scrap is still very quiet, and there are no prospects of any early expansion.

Approximate selling prices for old metal:—New aluminium cuttings, £80; rolled, £63; cast, £38; foil, £88. Copper, £36 to £38; braziery, £32 to £33. Brass (clean), £23 to £24. Zinc, £7 10s. Lead, £12. Gunmetal, £36 to £38.

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Rooms, Barrels, & Chambers.

WE SHOT AND SAND BLAST FOR ALL TRADES

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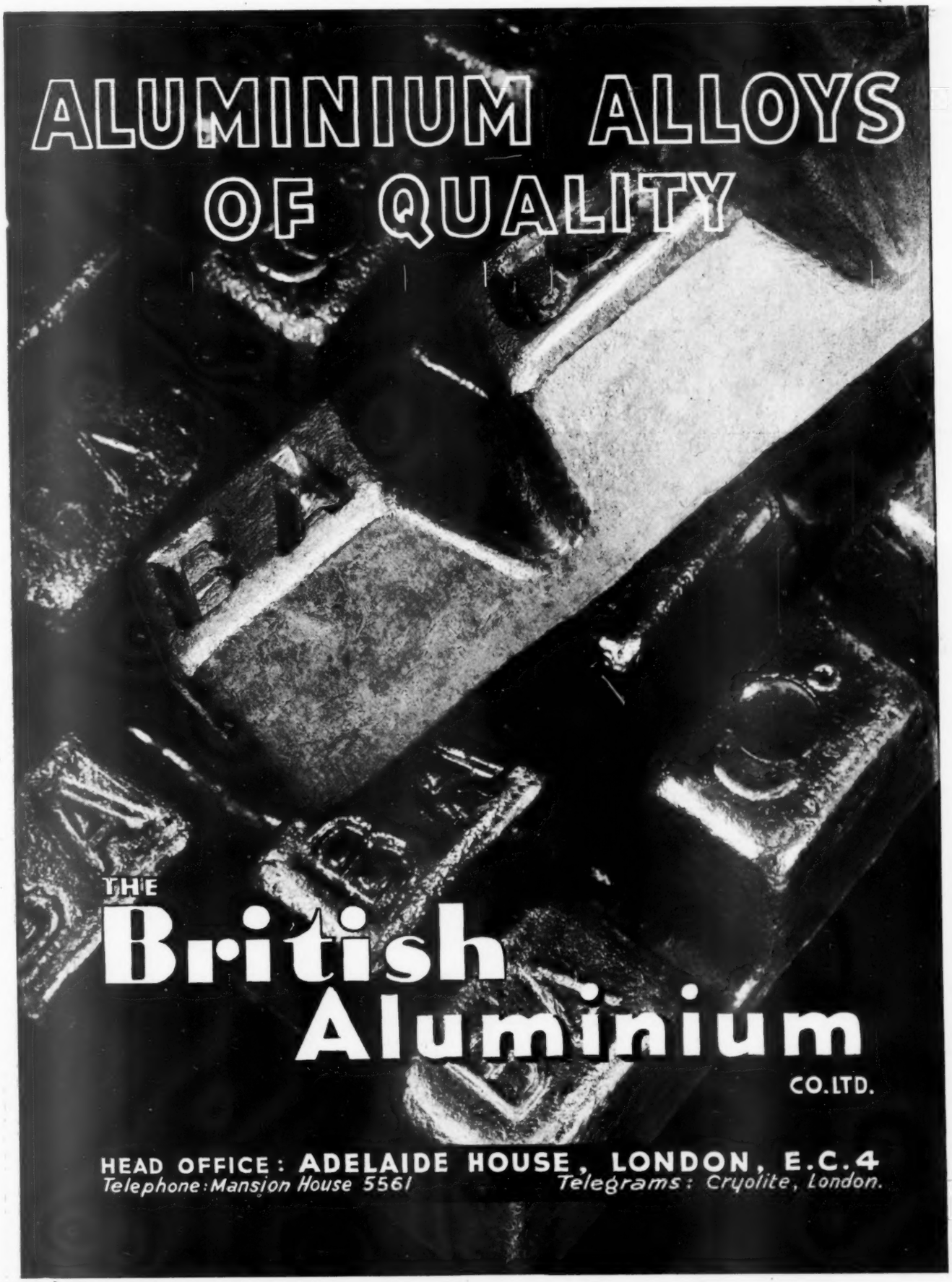
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HEAD OFFICE: ADELAIDE HOUSE, LONDON, E.C.4
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RAW MATERIALS—PRICE LIST

(Wednesday, March 30, 1938)

COPPER

	£	s.	d.
Standard cash	38	1	3
Three months	38	6	3
Electrolytic	42	0	0
Tough	41	1	3
Best selected	41	11	3
Sheets	72	1	3
India	54	3	9
Wire bars	42	16	3
Ingot bars	42	16	3
H.C. Wire rods	46	6	3
Off, av. cash, Feb.	39	12	10½
Do., 3 mths., Feb.	39	17	1⅞
Do., Sttlmnt., Feb.	39	13	0
Do., Electro, Feb.	43	19	2½
Do., B.S., Feb.	43	10	7½
Do., Wire bars, Feb.	44	7	1½
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8¼d.

BRASS

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	9d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	8½d.
Wire	8½d.
Rolled metal	7¼d.
Yellow metal rods	6¼d.

TIN

	£	s.	d.
Standard cash	173	0	0
Three months	173	5	0
English	173	0	0
Bars	175	0	0
Straits	177	0	0
Eastern	175	15	0
Banca (nom.)	—		
Off. av. cash, Feb.	183	5	3¾
Do., 3 mths., Feb.	183	2	9¾
Do., Sttlmt., Feb.	183	4	6

SPELTER

	£	s.	d.
Ordinary	13	16	3
Remelted	11	10	0
Hard	11	5	0
Electro, 99.9	17	12	6
English	15	7	6
India	13	10	0
Zinc dust	20	0	0
Zinc ashes	5	5	0
Off. aver., Feb.	14	9	11⅝
Aver., spot, Feb.	14	8	1⅞

LEAD

	£	s.	d.
Soft foreign, ppt.	15	18	9
Empire (nom.)	17	2	6
English	18	0	0
Sheets, home	24	0	0
Do. export	20	7	6
Pipes, home	23	10	0
Do. export	21	0	0
Tea lead	32	10	0
Off. aver., Feb.	15	9	3 7/16
Aver., spot, Feb.	15	8	0⅜

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	28	15	0 to 29	5	0
Do., V.M. ex-whse.	28	15	0 to 29	5	0
Rods			20	10	0

ANTIMONY

English	81	0	0 to 82	0	0
Chinese, ex-whse.			67	0	0
Crude, c.i.f.			40	0	0

QUICKSILVER

Quicksilver	13	2	6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—			
25%	12	10	0
45/50%	12	0	0
75%	17	0	0
Ferro-vanadium—			
35/50%	14/- lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	4/9 lb. Mo.		
Ferro-titanium—			
20/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£21 to £22		
Ferro-tungsten—			
80/85%	6/- lb. (nom.)		
Tungsten metal powder—			
98/99%	6/1½ lb. (nom.)		
Ferro-chrome—			
2/4% car.	34	15	0
4/6% car.	24	5	0
6/8% car.	24	0	0
8/10% car.	24	0	0
Ferro-chrome—			
Max. 2% car.	36	0	0
Max. 1% car.	38	5	0
Max. 0.5% car.	41	0	0
70% carbon-free	10d. lb.		
Nickel—99.5/100%	£180 to £185		
"F" nickel shot	£165	0	0
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.		
Metallic chromium—			
96/98%	2/5 lb.		
Ferro-manganese—			
76/80% loose	£18 15 0 to 19	5	0
76/80% packed	£19 15 0 to 20	5	0
76/80% export	£22	0	0
Metallic manganese—			
94/96% carbon-free	1/3 lb.		

Per ton unless otherwise stated, basis 2-ton lots.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)—						
Heavy steel, best	3	8	9 to 3	11	3	
Mixed iron and steel	3	6	9 to 3	9	3	
Heavy cast iron	3	8	9 to 3	11	3	
Good machinery			3	12	6	
Cleveland—						
Heavy steel, best	3	7	0 to 3	9	6	
Steel turnings	2	13	0 to 2	15	6	
Heavy cast iron			4	0	0	
Heavy machinery			4	5	0	
Midlands—						
Short heavy steel			3	15	0	
Light cast-iron scrap			3	2	6	
Heavy wrought iron	4	0	0 to 4	5	0	
Steel turnings	2	6	3 to 2	8	9	
Scotland—						
Heavy steel, best	3	5	0 to 3	7	6	
Ordinary cast iron	4	0	0 to 4	2	6	
Cast-iron borings	2	0	6 to 2	3	0	
Wrot-iron piling	4	5	0 to 4	7	6	
Heavy machinery			4	6	6	

London—Merchants' buying prices, delivered yard.

Copper (clean)	33	0	0
Brass	23	0	0
Lead (less usual draft)	15	0	0
Tea lead	13	0	0
Zinc	7	10	0
New aluminium cuttings	67	0	0
Braziery copper	30	0	0
Gunmetal	33	0	0
Hollow pewter	130	0	0
Shaped black pewter	90	0	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 6d.
Finished bars, 18% tungsten	4s. 6d.

Per lb. d/d buyers' works.

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	111/6
„ No. 3	109/-
„ No. 4	108/-
Forge No. 4	108/-
Hematite No. 1	133/-
Hematite M/Nos.	132/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	133/-
„ d/d Birm.	144/6
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	110/-
„ No. 3 fdry.	111/-
Northants forge	107/6
„ fdry. No. 3	108/6
„ fdry. No. 1	111/6
Derbyshire forge	110/-
„ fdry. No. 3	111/-
„ fdry. No. 1	114/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
„ No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
„ „ Falkirk	109/-
Scottish hem. M/Nos. d/d	133/-
Sheffield (d/d district)—	
Derby forge	107/6
„ fdry. No. 3	108/6
Lincs forge	107/6
„ fdry. No. 3	108/6
W.C. hematite	138/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	141/-
Clyde, No. 3	141/-
Monkland, No. 3	141/-
Eglinton, No. 3	141/-
Gartsherrie, No. 3	141/-
Shotts, No. 3	141/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to 13	15	0	
Nut and bolt iron	11	12	6 to 12	2	6	
Hoops			14	2	6	
Marked bars (Staffs) f.o.t.			15	15	0	
Gas strip			14	2	6	
Bolts and nuts, ¾ in. × 4 in.			17	10	0 and up	
Steel—						
Plates, ship, etc.	11	8	0 to 11	10	6	
Boiler plts.	11	18	0 to 12	0	6	
Chequer plts.			13	0	6	
Angles			11	0	6	
Tees			12	0	6	
Joists			11	0	6	
Rounds and squares, 3 in. to 5½ in.			12	0	6	
Rounds under 3 in. to ¾ in. (untested)			11	9	0	
Flats—8 in. wide and over			11	5	6	
„ under 8 in. and over 5 in.			11	10	6	
Rails, heavy			10	2	6	
Fishplates			14	2	6	
Hoops (Staffs)			12	4	0	
Black sheets, 24g. (4-t. lots)			15	15	0	
Galv. cor. shts. („)			18	10	0	
Galv. flat shts. („)			19	0	0	
Galv. fencing wire, 8g. plain			20	5	0	
Billets, soft, 100-ton lots			7	17	6	
Sheet bars			7	15	0	
Tin bars			7	15	0	

PHOSPHOR BRONZE

	Per lb. basis
Strip	10¾d.
Sheet to 10 w.g.	11½d.
Wire	12¾d.
Rods	13½d.
Tubes	18½d.
Castings	15d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.84
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6		
„ furnace	34/6		
Durham foundry	39/6		
„ furnace	32/6		
Scottish foundry	42/6		
„ furnace	40/-		

TINPLATES

f.o.b. British Channel ports.

I.C. cokes	20×14 per box		22/6
„	28×20 „		45/-
„	20×10 „		32/4
„	18¾×14 „		23/5
C.W.	20×14 „		20/-
„	28×20 „		42/6
„	20×10 „		28/8
„	18¾×14 „		20/9

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£11	0	0 to £12	0	0	
Bars-hammered, basis	£20	0	0 to £22	0	0	
Bars and nail-rods, rolled, basis	£19	0	0 to £20	0	0	
Blooms	£18	0	0 to £19	0	0	
Keg steel	£30	0	0 to £35	0	0	
Faggot steel	£20	0	0 to £25	0	0	
Bars and rods dead soft st'l	£19	0	0 to £20	0	0	

All per English ton, f.o.b. Gothenburg [Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.		
Mar.	24	..	39	6	3	inc.	2/6
,,	25	..	39	10	0	,,	3/9
,,	28	..	38	12	6	dec.	17/6
,,	29	..	39	0	0	inc.	7/6
,,	30	..	38	1	3	dec.	18/9

Electrolytic Copper

			£	s.	d.		
Mar.	24	..	43	0	0	No	change
,,	25	..	43	5	0	inc.	5/-
,,	28	..	42	10	0	dec.	15/-
,,	29	..	42	15	0	inc.	5/-
,,	30	..	42	0	0	dec.	15/-

Standard Tin (cash)

			£	s.	d.		
Mar.	24	..	183	10	0	dec.	20/-
,,	25	..	184	7	6	inc.	17/6
,,	28	..	183	0	0	dec.	27/6
,,	29	..	182	10	0	,,	10/-
,,	30	..	173	0	0	,,	190/-

Tin (English ingots)

			£	s.	d.		
Mar.	24	..	183	10	0	dec.	20/-
,,	25	..	184	7	6	inc.	17/6
,,	28	..	183	0	0	dec.	27/6
,,	29	..	182	10	0	,,	10/-
,,	30	..	173	0	0	,,	190/-

Spelter (ordinary)

			£	s.	d.		
Mar.	24	..	14	6	3	inc.	1/3
,,	25	..	14	6	3	No	change
,,	28	..	14	2	6	dec.	3/9
,,	29	..	14	3	9	inc.	1/3
,,	30	..	13	16	3	dec.	7/6

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
Mar.	24	..	18	2	6	inc.	1/3
,,	25	..	18	5	0	,,	2/6
,,	28	..	17	17	6	dec.	7/6
,,	29	..	18	0	0	inc.	2/6
,,	30	..	17	12	6	dec.	7/6

Lead (soft foreign, prompt)

			£	s.	d.		
Mar.	24	..	16	1	3	No	change
,,	25	..	16	5	0	inc.	3/9
,,	28	..	16	6	3	,,	1/3
,,	29	..	16	6	3	No	change
,,	30	..	15	18	9	dec.	7/6

Lead (English)

			£	s.	d.		
Mar.	24	..	18	0	0	No	change
,,	25	..	18	5	0	inc.	5/-
,,	28	..	18	5	0	No	change
,,	29	..	18	5	0	,,	,,
,,	30	..	18	0	0	dec.	5/-

AVERAGE MONTHLY PRICES OF STEEL RAILS

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1930	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1931	8 9 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 8
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1934	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1935	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1936	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1937	8 7 6	8 7 6	8 7 6	8 7 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	9 10 10
1938	10 2 6	10 2 6	10 2 6	—	—	—	—	—	—	—	—	—	—

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE MIXED NUMBERS AT MIDDLESBROUGH*

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928	69 7½	69 7½	69 9	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	74 0	74 1½	74 9	75 6	76 1½	76 8½	78 1½	79 0	74 11½
1930	78 2½	78 0	76 9	75 0	74 0	72 7½	71 0	71 0	71 0	71 0	70 10½	70 4½	73 3½
1931	70 0	69 0	68 0	66 8½	65 1½	63 4½	62 9	61 1½	65 0	65 0	65 0	65 0	65 6
1932	64 10	64 3	63 6	63 6	63 6	62 7½	62 0	60 6	60 0	59 3	59 0	59 0	61 10
1933	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 3	60 7½	62 6	62 6	59 8½
1934	62 6	65 0	67 6	67 6	67 6	67 6	67 6	67 6	68 0	68 6	68 6	68 6	67 2
1935	68 6	68 6	68 6	68 6	68 6	68 6	69 7½	70 6	70 6	70 6	70 6	70 6	69 5½
1936	70 6	75 3	76 6	76 6	77 4	80 0	85 0	85 0	85 0	85 0	85 0	85 0	80 6
1937	97 6	97 6	97 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	114 2
1938	132 6	132 6	132 6	—	—	—	—	—	—	—	—	—	—

* Since March, 1934, delivered works; previously f.o.t. furnaces. NOTE.—Prices of hematite have since July 1, 1936, been subject to a rebate of 5s. under certain conditions.

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Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed in the manner indicated in the Form of Tender, must be delivered at the offices of the Board (Room 122) not later than 12 o'clock Noon on Monday, April 11, 1938.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
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E.C.1.
March 17, 1938.

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